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THE UTICA AND LORRAINE FORMATIONS OF NEW YORK

PART 2 SYSTEMATIC PALEONTOLOGY

No. 2 Mollusks, Crustaceans and Eurypterids

BY

RUDOLF RUEDEMANN

PAGE
Preface........................ 5
Descriptions of fossils........... 6
  Pelecypoda................... 6
  Gastropoda................... 58
  Cephalopoda.................. 80
  Trilobita.................... 106
  Ostracoda.................... 137
  Cirripedia................... 145

PAGE
Descriptions of fossils — *concluded*
  Phyllocarida................. 147
  Merostomata.................. 149
List of species of Utica and Lorraine formations.............. 156
Bibliography.................... 165
Explanation of plates............ 169
Index.......................... 225

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PART 2 SYSTEMATIC PALEONTOLOGY

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PREFACE

The first instalment of the monograph of the Utica and Lorraine formations of New York, dealing with the stratigraphy was printed as New York State Museum Bulletin 258 (1925); the second containing the first part of the systematic paleontology (plants, sponges, corals, graptolites, crinoids, worms, bryozoans and brachiopods) as Bulletin 262 (1925). The present instalment closes the work by furnishing the descriptions of the mollusks, crustaceans and eurypterids.

Owing to the necessity of reducing the cost of printing as far as possible, forms that have been described and figured before in state publications, have been refigured only when it was thought that new characters could be shown. The reader is directed for descriptions of these forms, among them the most common species of the Utica and Lorraine, to volume 1 of the Palaeontology of New York. A very full account, with excellent new photographs and copies of older figures, of many of our Lorraine forms is found in A. F. Foerste's Upper Ordovician Faunas of Ontario and Quebec. (Memoir 138 of the Geological Survey of Canada, 1924).

A small number of lamellibranchs of the New York Lorraine, which were cited in the fossil lists of part 1 had to be omitted because the specimens, descriptions and figures were not available when this last instalment went to press. They are cited as manuscript names in the final list on p. 160 and 161 and will have to stand as *nomina nuda* until it will be possible to publish them.

Phylum **Mollusca**

Class **Pelecypoda**

Order **Prionodesmacea**

Family **Grammysiidae** Fischer

Genus **Cuneamya** Hall and Whitfield

Cuneamya subquadrangularis nov.

Plate 1, figures 1 and 2

Description. Shell of medium size, of subquadrangular outline, slightly elongate, the anterior and posterior ends of nearly equal length and the margins subparallel; and likewise the cardinal and ventral margins of subequal length and approximately parallel. Beaks prominent, nearly terminal, strongly incurved. Anterior end nearly vertical in upper part, truncate in lower part. Basal margin gently convex; posterior margin nearly straight and vertical, postero-cardinal angle rounded, continued into the convex cardinal margin. Posterior umbonal ridge little prominent, type, however, somewhat crushed and not conclusive as to this character. Cardinal slope gently convex, a narrow, slightly curved anterior umbonal ridge, extends from the umbo toward the anteroventral margin. Surface marked by about twelve strong, nearly equal, concentric undulations or ridges, which are strongest on the anterior ridge and median sulcus and become obsolete toward the posterior margin and on the cardinal slope. Upon and between these undulations there are fine growth-lines which become especially distinct towards the anterior margin, where the undulations appear as bunched growth-lines. The anterior umbonal ridge and the sulcus are also marked by very delicate, straight to wavy, vertical lines, that are only visible with a strong lens and so fine, that eight are counted in the space of 1 mm.

Hinge and muscular impressions, as well as the escutcheon and the lunule are not seen in the specimen.

Measurements. Length of specimen 28 mm; greatest height at front 17 mm; height in middle 17 mm.

Horizon and locality. Dark gray argillaceous shale, top of Utica, at Holland Patent, N. Y.

Remarks. This species is based on a single specimen in the United States National Museum (no. 34,473). It is interesting as the single representative of the genus Cuneamya in the Utica shale. It is similar in outline to the Lorraine form C. scapha brevior Foerste, but differs in being relatively higher and shorter and having straighter, less oblique anterior and posterior ends. In the forward position of the umbo and the vertical anterior end the species agrees with the western Galena form C. truncatula Ulrich which, however, is more elongate and has a subalate postero-cardinal region. Still nearer to our species is the form from the Trenton of New Jersy identified by Weller (1903, plate 11, figure 6) with C. truncatula. The concentric undulations are stronger and more closely arranged in our specimen than in truncatula but agree with those of C. oblonga Ulrich, another Galena form, with which C. subquadrangularis has also the subvertical, nearly straight posterior end in common. In general, it thus seems that the Utica species forms a transition between characters of the earlier C. truncatula and C. oblonga on one side, and the later C. scapha brevior on the other, being, however, shorter and higher than any of them.

Cuneamya sp. aff. **neglecta** (Meek)

Plate 1, figures 3 and 4

Grammysia neglecta Hall and Whitfield Geol. Surv., Ohio, Pal. 2, 1875, p. 91, pl. 2, fig. 11

Shell obliquely ovate longitudinally, the lower posterior angle rounding more rapidly than any other part of its outline. Beaks large and ventricose, arching upward and forward so as to produce a nearly vertical outline along the anterior face of the shell. Posterior to the beak the cardinal and ventral margins approach each other at a moderate rate. Posterior end of hinge-line merging gradually into upper posterior outline, forming an angle of about 50 degrees with the latter (Foerste 1925).

The State Museum contains a small series of slabs of black shale which are filled with a small Cuneamya, that according to Doctor Ulrich are near to neglecta (Meek). The slabs come from the Whetstone Gulf shale at Rodman, Jefferson county, N. Y., abou 6 miles north of Lorraine village. The fossil was labeled "Modiolopsis sinuata Emmons" and one of them (see plate 1, figure 3) proved to be the original of Hall's third figure (plate 82, figure 3*c*) of his Modiolopsis anodontoides (M. sinuata Emmons). The specimens are associated with Pholidops cincinnatiensis and Triarthrus eatoni.

The specimen which Hall figured, like most of those in the shale is much flattened and at the same time compressed vertically or foreshortened near the basal margin, making the valves appear too elongate. Other specimens are less compressed and show more of the original ventricose nature of the umbonal region. The anterior end is very short and broadly rounded, the posterior margin very oblique in the upper part and rather sharply bent at the postero-basal angle. The lunule is small. Hinge and muscle-scars have not been observed in our material. Hall's originals are 12 mm long; their height is not measurable; the other specimen figured has a height of 8.3 mm; its thickness is 2 mm.

The concentric striae or narrow undulations are very distinct anteriorly, but become less distinct posteriorly of the umbonal ridge and in some specimens disappear almost entirely near the cardinal margin, similarly as in C. scapha-brevior. They number about seven in 2 mm on the middle of the umbonal ridge. Sometimes the undulations break up into bundles of growth-lines.

Specimens bearing the character of this species occur also in a dark gray to black shale of the lower Whetstone Gulf formation north of Rome, (Rust collection, Museum number R1232) that is filled with Triarthrus eatoni, Cryptolithus bellulus and Dalmanella multisecta.

Another form of Cuneamya with coarser ribs, that also is very similar to C. neglecta, has been found by the writer at Worthville (station 22*a*) and is here reproduced in plate 1, figure 4,

Cuneamya elliptica Miller

Plate 1, figure 5

Cuneamya elliptica Miller. Jour. Cincinnati Soc. Nat. Hist., 4, 1881, p. 317, pl. 8, figs. 3, 3*a*

Shell longitudinally elliptical in outline except at the beak which projects diagonally upward and forward like in other species of the genus. Anterior margin projects in front of the beak sufficiently to produce a concave outline along the lunule, sloping downward and forward at about 65 degrees with the hinge-line. Shell ventricose along the umbonal ridge. The ridge becomes broadly rounded posteriorly, merging into the general convexity of the shell. A faint mesial sulcus extends downward and backward from beak at 75 degrees with hinge-line (Foerste, 1925).

This species was originally described from the McMillan member of the Maysville, Cincinnati, Ohio. Foerste (1925, p. 133) has found " a specimen somewhat similar in outline in the Pulaski member of the Lorraine formation, at Pulaski, New York," and Ulrich has identified a smaller specimen from the base of the Pulaski (Worthville, station *22a* of the Lorraine gorge section) with Miller's species.

Cuneamya scapha Hall and Whitfield

cf. mut. **brevior** Foerste

Plate 1, figures 6 and 7

Foerste (1914, p. 307) has described and figured as Cuneamya scapha-brevior an earlier mutation of the Richmond species C. scapha Hall and Whitfield, from the Pulaski beds of the province of Quebec. More recently (1916, p. 6–7) he has also cited this fossil from the outcrops in the village of Lorraine, along the road between Lorraine and Worthville, and at Worthville.[1]

These occurrences have been verified by the writer and the form also observed as a not uncommon fossil at station *22a*, Lorraine gorge and in the lower Whetstone Gulf formation north of Rome (Russ collection R 1232). This species or a very closely related type would thus seem to occur rarely in the Whetstone Gulf formation but principally in the basal zone of the Pulaski.

Foerste has furnished the following description of its characters:

> Shell closely related to Cuneamya scapha, but relatively shorter, and hence with a less inclined umbonal ridge and mesial sulcus. The angle between the umbonal ridge and the hinge-line is approximately 45 to 50 degrees, the median part of the mesial sulcus forming an angle of about 70 degrees. The mesial sulcus has a width of about 15 mm near the basal margin, and is distinct even close to the beak, although this may be only an individual characteristic. The beak is broader and far less acute than is indicated in the figure of the type presented in the second volume of the Paleontology of Ohio. The anterior outline, however, is closely similar. The umbonal ridge is rounded, not angular, and the posterior margin is more evenly rounded posteriorly. Concentric striae or low narrow undulations fairly distinct anteriorly, becoming fainter along the umbonal ridge and on the cardinal slope.
>
> Length 32 mm; height at posterior end 18 mm; height at beak 20 mm; extension of shell anterior to beak 3 or 4 mm; length of lunule about 7 or 8 mm.

The concentric undulations upon the umbonal ridge are a very prominent and characteristic feature of the shale specimens, and where the sculpture is especially well preserved, extremely fine but sharp radiating striae are seen passing over the corrugations. They are especially distinct upon the smooth posterior part, but so small that they number twelve in 1 mm and are barley visible with a strong lens.

---

[1] Not mentioned in last publication (1925, p. 132) and probably considered a distinct species.

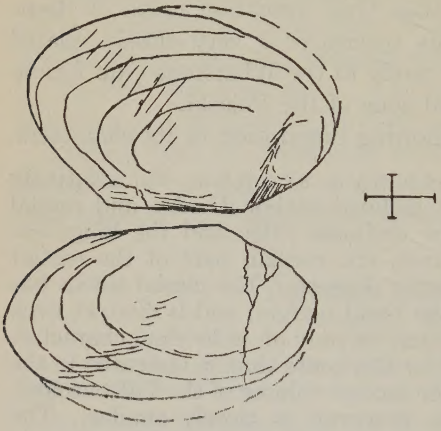
Superfamily **Nuculacea**

Family **Ctenodontidae** Dall

Genus **Ctenodonta** Salter

Ctenodonta nuculiformis (Hall)

Ctenodonta nuculiformis has been described and figured by Hall (1847, p. 298) as Modiolopsis nuculiformis. As localities are cited the Utica slate at Turin; that in Montgomery county and the " glazed and partially metamorphic slates of Waterford, Saratoga county." As the shales in Montgomery county are all, or nearly all, Canajoharie shale of Trenton age, and those at Waterford belong partly to the Canajoharie shale and partly to the Schenectady beds and are thus also prevailingly of Trenton age, it is probable that different forms are here united into one species. Only the type of the Turin occurrence, reproduced in Hall's plate 82, figure 5*a* is extant (in the American Museum of Natural History) and it is therefore necessary to restrict the species to this form.



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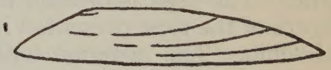

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Figure 1 Ctenodonta nuculiformis (Hall). Outline-drawing by camera of Hall's type. x 4.5. Figure 2 Side view of same (free hand drawing.)

The type, now before me, consists of the exterior casts of the two valves expanded. The valves are still imbedded in the shale and partly covered by the matrix along the basal margins. They are 9 mm long and 5 mm high below the beak, but probably measure 1 mm more in height. The " shallow sinus ", (mesial sulcus) mentioned in the description and strongly emphasized in the figure, is extremely faint and narrow and the valves on the contrary very evenly convex. It appears that Hall was misled to this statement by his habit of frequently drawing up the descriptions from the figures.

The anterior margin is well rounded, the cardinal margin straight for about half the length of the valve, the posterior margin oblique and more sharply turned at the postero-basal angle; the basal margin is fairly convex, judging from the growth-lines. The beak is slightly projecting (as far as exposed) and somewhat prominent; the umbonal ridge merged into the general surface. The valves are evenly convex along the dorso-ventral line, exposing a thickness of about 1 mm. No hinge-teeth are observable. The anterior adductor muscle-scar is noticeable in one valve. It is rather large and directly adjacent to the frontal margin. Posteriorly of it, there is in both valves a faint perpendicular depression suggestive of a weak clavicle. The surface shows but traces of growth-lines near the basal margin, but instead of them about five broad flat concentric varices.

The appended outline has been drawn with the camera lucida from the type, and the covered part is suggested by a dotted line.

The species is, in our view, not in danger of being confused with any of the Eden species here cited and described, but approaches more closely to the Trenton species C. levata Hall, which is also represented in the Snake Hill beds and to which probably the specimens from Waterford and Montgomery county belong that Hall referred to nuculiformis. C. levata is a somewhat higher form with more projecting beak.

Ctenodonta pectunculoides (Hall)

Plate 1, figures 8–12

Hall, in the Twenty-fourth Report of the New York State Cabinet (1872, p. 228), describes this species, from a Cincinnati specimen, as Tellinomya pectunculoides, giving only an interior view and stating that the surface characters were not observed. Hall and Whitfield (1875, p. 81, plate 1, figure 24) reproduced the original figure and stated that they had only exfoliated specimens before them, that these however preserve the shell sufficiently to show that the surface was generally smooth and destitute of any markings of any kind.

Foerste (1925, p. 137) has briefly described this species as follows:

> Outline nearly circular, slightly straightened along the hinge-line, posterior to the beak. Height slightly shorter than length, in ratio of 9 to 10. Hinge-area of uniform width along its entire course, with about thirty short teeth. Size small.

The species was originally described from the "Hudson River beds" of Cincinnati and according to Bassler's Index, ranges from the Eden to the Maysville at Cincinnati and vicinity. It was also cited from Quebec by O'Neill (1914,) but Foerste (1916, p. 48) considers the form cited there as probably his C. lorrainensis. The dark gray shale and sandstone of stations 9, 10, 11 of the Whetstone gulf section were found to contain this species as a common fossil, often finely preserved with its surface characters, some of the specimens having been identified by Doctor Ulrich as being identical with the Cincinnati form.

These specimens are about 7 mm long and 6 mm high, and rather evenly convex, the only abrupt slopes being found along the cardinal and behind the anterior margin. The thickness of one valve amounts to about 1 mm. The anterior, basal and posterior margins are evenly rounded, giving the shell a subcircular outline; the cardinal margin is broadly arcuate. The beak is very small, somewhat prominent and not projecting, situated very far forward (about one-eighth the length of the shell behind the anterior margin). The hinge is as described by Hall. The surface is furnished with very uniformly spaced and very fine filiform growth-lines with smooth interspaces, except on the cardinal slope where traces of short radial lines are seen. The concentric lines number eight in the space of 2 mm.

This pretty shell occurs in the Whetstone gulf in beds that belong to the top of zone I and the base of zone II, or in beds that correspond approximately to the upper Economy and lower Southgate horizons of the Eden at Cincinnati.

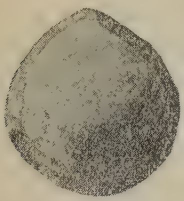
Ctenodonta lorrainensis Foerste

Doctor Foerste (1925, p. 137) describes this species as follows:

Shell small, rotund in outline, length and width about 9 mm, a slight tendency toward angulation at the posterior extremity, owing to a straightening of the posterior part of the arcuate hinge-line, as in Ctenodonta pectunculoides Hall, from the Mount Hope and Fairmount beds of the Maysville division of the Cincinnatian, Cincinnati, Ohio. In the latter species, however, the tendency is toward a greater length than height of the valves, whereas Ctenodonta lorrainensis tends toward a slightly greater height than width. This results in a less angulate posterior outline. Furthermore, the height of the hinge area, as compared with the rest of the shell, is less. Surface with very fine concentric striae, readily seen only under lens.

The species was originally reported by its author as occurring at the eastern edge of Lorraine village and to be still more abundant

2 miles west of Worthville. Later (1916, p. 231) it was recorded by the same authority from the Nicolet river section, Rivière des Hurons and Chambly in Quebec, as well as Hawthorne in Ontario East, apparently everywhere in beds of Pulaski age. In the Lorraine section we have found the species at stations 17, where it is very common, 20, 22*a*, 25 and 27*b*. It thus ranges rather well throughout the Pulaski beds and also occurs in the upper Whetstone Gulf formation (zone III, corresponding to the upper Southgate member). It is absent in the last zone of the Pulaski (zone VIII). Fine specimens are also occasionally seen in the rusty weathering calcareous sandstone blocks of the Lorraine drift material.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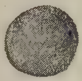
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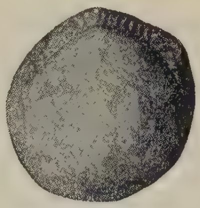
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Figure 3 Ctenodonta lorrainensis Foerste. Cast of interior of right valve. x 3. (From Foerste.)

Figures 4, 5 Ctenodonta borealis Foerste. Holotype, cast of interior of right valve; natural size and x 3. (From Foerste.)

We have figured several specimens, mainly to show the character of the hinge, which is strongly arcuate, and shows the same number of teeth as C. pectunculoides. The muscular-scars are similarly placed and sized as in the latter species, and the average size of both species is nearly equal.

Doctor Ulrich informs me that C. lorrainensis is identical with the higher of the two forms currently identified with C. pectunculoides, and that it is as yet undetermined which is the true pectunculoides.

Ctenedonta borealis Foerste

Ctenodonta lorrainensis (pars.) Foerste, Bull. Sci. Lab. Denison Univ., 17, 1914, p. 305, pl. 3, fig. 8B (not 8A).

Ctenodonta borealis Foerste. Mem. 138, Geol. Surv. Canada, 1924, p. 137, pl. 31, fig. 9; pl. 38, fig. 4.

Doctor Foerste has recently separated from his species C. lorrainensis a specimen from the Lorraine near Worthville, New York, formerly identified with that species, but distinguished from it by being " broader, more circular, the hinge (is) much broader, and teeth distinctly fewer."

Ctenodonta pulchella (Hall)

This species, as Lyrodesma pulchella, is described and figured by Hall (1847, p. 302) as a "Hudson River" fossil from the "black slate near Watertown" and the "metamorphosed" slate near Waterford. The former is interbedded with the limestone (at the base of the Trenton section) (Foerste, 1914, p. 305), the latter of Snake Hill age (Ruedemann, 1912, p. 104). Ctenodonta pulchella is thus no Lorraine species.

Ctenodonta filistriata Ulrich.

Plate 1, figures 13 and 14

A form that before was generally identified with Hall's Nucula or Tellinomya levata, has been distinguished by Ulrich in the Minnesota Report (1897, p. 599), as Ctenodonta filistriata. It is described by Foerste (1925, p. 134) as follows:

> Outline subrhomboidal ovate. Maximum curvature of the ventral outline directly beneath the beaks, posterior to this the ventral outline tends to straighten slightly and to rise at an angle of 13 to 15 degrees. Umbonal ridge fairly distinct, and outline of the shell along the lower posterior angle rather narrowly rounded. Posterior margin only gently rounded and forming an angle of 50 to 65 degrees with the hinge-line. On casts of the interior of the valves, the beaks are relatively prominent and narrow.

The species is thus far known from the Eden at Covington, Kentucky (Bassler, 1915, p. 304) and Foerste (1916, p. 231) has also identified, tentatively, specimens from the Nicolet River section in Quebec and Manitoulin Island with the Ohio form.[1] In the New York sections C. filistriata was collected at stations 6, 7, 11, 12, 13 and 14 of the Lorraine gulf section; station 5 of the Whetstone gulf section; stations 9, 10, 12 and 15 of the Mill creek section; station 11 and 12 of the Moose creek section; and stations 1, 2, 3, 4 and 7 of the Wood creek section. A great number of well-preserved specimens in black shale were also found in the Rust collection (collected by Valiant near Rome) in the State Museum, and the United States National Museum. The species is thus a common member of the Whetstone Gulf faunas and ranges throughout the greater part of the formation, being most common in the lower zones and apparently absent in the last two zones (III and IV), where it is replaced by C. perminuta and C. lorrainensis.

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[1] It has since also been identified by Miss Stewart (1920, p. 9) in collections from the Humber River cut at Toronto, but Foerste (1925, p. 134) considers this a new form.

The species is readily distinguished from the associated C. pectunculoides by its fine threadlike lines, from the following C. lorrainensis by its more elongate form; its length being to its height approximately as 4:3. It reaches a larger size than the two congeners, its length measuring 11.5 mm and its height 8.5 mm in a large representative specimen. Ulrich's figures indicate a still larger size for the types.

Ctenodonta perminuta Ulrich

Original description (Ulrich 1893, p. 680):

Shell very small, commonly about 1.5 mm in length and 1.15 mm in height, widest anteriorly; anterior outline rounded below, generally nearly vertical in the upper half, and subangular in the anterocardinal region; basal margin broadly convex, posterior end obliquely truncate, strongly rounded in the lower half. The species is known from casts of the interior only. In these the beaks are prominent, moderately incurved, and situated between one-fourth and one-third of the entire length behind the anterior extremity. The muscular impressions are unusually distinct for so small a shell, and the structure of the hinge seems to have been very much as in C. levata Hall sp. and other forms of that section of the genus.

The extreme minuteness of the shell and the comparative strength of the muscular attachments will distinguish this form at once from all other species of the genus having a similar shape.

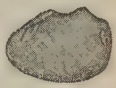
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Figure 6 Ctenodonta perminuta Ulrich. Cast of right valve. x 6 (From Ulrich).

The species ranges, according to Bassler's Index, from the Eden to the Maysville and is known from Cincinnati and vicinity. In New York we have found the species quite common at station 14 of the Whetstone gulf section and at the outcrop in the bank of the river, 2 miles below Pulaski; where it is associated with Arthropora cincinnatiensis (James). In both localities it is common.

While Ulrich's material consisted of casts of the interior only, ours is largely made up of shells preserving the exterior. It is seen by these that the exterior was nearly smooth, only faint growth-lines being visible, under the lens, near the basal margin, which are not threadlike or raised, as in C. filistriata and lorrainensis.

The majority of our specimens are slightly larger than the type material, the average height reaching 2 mm and a few even attaining a height which is double that given by Doctor Ulrich.

Family **Ledidae** Adams

Genus **Clidophorus** Hall

Clidophorus planulatus (Conrad)

Clidophorus planulatus is recorded by Bassler as occurring in both the Eden and Maysville formations. It likewise is found in New York in both the Whetstone gulf and Pulaski divisions of the Lorraine group and ranges from the lowest zone, corresponding to the Economy member of the Eden, to the highest beds exposed at the Salmon River falls.

A survey of a series of specimens from these different horizons shows, however, that there are noticeable differences. It is therefore important to accurately define the typical expression of the species.

Conrad (1841, p. 50) described the species as Nuculites planulata as follows:

> Compressed, ovate-acute; posterior dorsal margin oblique, rectilinear, extremity acutely rounded; basal margin regularly arched; rib oblique.

As locality, Pulaski, Oswego county, is given.

Conrad did not figure his species and the first figure was furnished by Emmons (1842, p. 399). It is, however, obvious that this is not a figure of Conrad's type specimen, for the species is termed Nuculites scitula by Emmons and cited as "extremely common immediately below the loraine shales, or in the upper part of the utica slate" (meaning the dark lower shales of the Whetstone Gulf formation). Emmons' figure also clearly represents a specimen of the lower shales, and thus can not be considered as a type figure.

Hall described and figured the species more fully in Palaeontology of New York, volume 1 (1847, p. 300), erecting there the genus Clidophorus for clavicle bearing shells of the character of planulatus. Of the originals of his figures that of 9*a* is in the State Museum, those of 9*b*-*e* are in the American Museum; the last one representing a species from Snake Hill beds at Waterford, N. Y. All the other specimens are from Turin. At this place only the lowest beds of the Pulaski formation are exposed at the end of the section (see Mill creek section, pt. 1, p. 45). From these lowest Pulaski beds is the slab of arenaceous shale in the State Museum; the other types are imbedded in shale and from the Whetstone Gulf formation. All of Hall's originals come hence from horizons below that of Conrad's type, and exhibit differences to be noted below.

The Clidophorus planulatus of the higher Pulaski beds which occurs at Pulaski and served as Conrad's type has been carefully described by Foerste (1916, p. 302) from specimens obtained at Pulaski (topotypes), as follows:

> Shell transversely elliptical oblong, height about half the length of the shell, with the beak approximately a third of the length of the shell from the anterior end. Umbonal ridge low, distinctly defined along its cardinal border where it makes an angle of 162 to 165 degrees with the longitudinal axis of the shell. Above this umbonal ridge, the posterior cardinal slope of the shell is flattened and subalate. The posterior part of the hinge-line extends from the beak for a distance equalling about two-fifths of the length of the shell, and then makes an angle of about 150 degrees with the posterior margin of the shell. The margin is rather strongly rounded at both the posterior and anterior ends of the shell, the maximum curvature of the anterior margin, however, being nearer the hinge-line. The basal margin is moderately and evenly convex. The clavicular adductor support anterior to the beak forms an angle of about 80 degrees with the longitudinal axis of the shell; it is comparatively straight and extends downward to about the middle height of the shell; it is sharp and narrow, appearing on the cast of the interior of the shell as a sharp incision not depressing the immediately adjoining part of the shell. The convexity of the shell is moderate, that of a shell 9 mm in height being about 1.6 mm. Specimens 20 mm in length occur. Compared with the specimens figured by Hall from Turin, the Pulaski forms are relatively longer and hence are more convex along the anterior and posterior outlines.

Foerste points out that all of the specimens of Clidophorus planulatus from Turin, were figured by Hall as having more oblique clavicular adductor supports anterior to the beak; that, however, of the shale specimens (9*b*, *c*, *d*) only 9*d* presents a very oblique clavicle, approximately 55 degrees, while the originals of figures 9*b* and 9*c* show angles as steep as 75 to nearly 80 degrees. Likewise, we found that the three originals of figure 9*a* have, contrary to the drawing, very steep clavicles, the middle specimen having even an almost perpendicular one. This slab, however, as mentioned before, comes from the lowest Pulaski horizon.

At the other hand, the shale specimens from Rome, have, as noted by Foerste, more oblique clavicular supports. Since, however, occasional specimens from the type locality, east of Pulaski, also have very oblique clavicular adductor supports, Doctor Foerste is not certain whether these specimens with the more oblique clavicles should be regarded as distinct from the forms with near perpendicular impressions and considers it possible that this angle may vary in different individuals of the same species.

With a very large series of specimens from the dark shale of the lower Whetstone Gulf formation at Rome, as well as numerous specimens from various horizons of the Whetstone Gulf and Lorraine formations before us, we have been able to ascertain that while there is probably no sufficient differentiation in the relative proportions of height and length between the Whetstone Gulf and Pulaski forms, the slant of the clavicular support forms a fairly reliable criterion for while there are specimens with a large angle, the great majority have less steeply inclined clavicular adductor supports. In one lot of twenty-five specimens from the black Whetstone Gulf shale north of Rome, there were only four with angles of 80 degrees or more, while the remainder showed angles of 70 degrees or below.

The more oblique direction of the clavicle holds true for the material from practically the whole[1] Whetstone Gulf formation, as is evidenced here by the representative specimens figured from stations 8 and 9 of the Wood creek section and station 17 of the Lorraine section. It therefore deserves recognition as characterizing a mutational form of the typical Clidophorus planulatus of the Pulaski beds, for which the name scitulus Emmons is proposed. There are no observations and figures extant as to the hinge of Clidophorus planulatus nor have we been able to find a complete hinge. The nearest approach are the specimens figured (plate 6, figures 17, 18), which show the posterior end of the hinge, indicating that the hinge plate was narrow, did not extend to half the length of the shell, and bore a series of minute, thin teeth of unknown, but probably relatively large number.

The muscular scars, in spite of the deep clavicular support of anterior adductor muscle are so shallow that they are but rarely and faintly visible.

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[1] It is, however, to be noted that the appearance of typical Clidophorus planulatus at station 12 of the Mill creek section (near the top of the Southgate) indicates that it also goes below the Pulaski formation.

Clidophorus scitulus Emmons

Plate 6, figures 14–18

Nuculites scitula Emmons. Nat. Hist. N. Y. Geology, 2d Distr. 1842, p. 399, fig. 2.

The Whetstone Gulf formation contains a Clidophorus that is well characterized by its oblique clavicle. Emmons states that his species Nuculites scitula which has been cited by Hall, Bassler and others as a synonym of C. planulatus is "extremely common immediately below the Lorraine shales" and his figure shows distinctly the very oblique clavicle. As Emmons drew the lower boundary of his Lorraine shales, where Triarthrus eatoni disappears, it is clear that his specimens came from the Whetstone Gulf formation; and there is little doubt that his name being based on a figure and on the horizon of the species has standing according to the International Code of Zoological Nomenclature which is currently followed by paleontologists.

Foerste (1916, p. 302) noted that the Pulaski forms of C. planulatus are relatively longer than the Turin forms figured by Hall and that the clavicular impressions are more nearly perpendicular. In his last publication (1925, p. 138) he clearly extends the diagnosis to cover all variations. Also Stewart (1920, p. 12) states that the position of the clavicular impressions varies greatly in the Toronto rocks, but at the same time separates an extreme variety with highly oblique clavicular impressions and long anterior extension as C. obliquus.

Our observations (see under C. planulatus) indicate that the Pulaski forms (C. planulatus) on the whole, have steeper clavicular impressions than the Whetstone Gulf forms (C. scitulus) by about 10 degrees, that they are smaller and relatively longer. For these reasons we have used Emmons' name in our book in part 1 to recognize this difference.

Superfamily **Arcacea**

Family **Cyrtodontidae** Ulrich

Genus **Ischyrodonta** Ulrich

Ischyrodonta unionoides (Meek)

Plate 2, figures 1–3

Ischyrodonta unionoides is one of the names that have been proposed for a rather expressionless shell that is very common in our Pulaski formation, but that, owing to its lack of characteristic features, has failed to be properly distinguished by the earlier authors.

It was first adequately described and figured from western specimens by Meek (1873, p. 141) as Anodontopsis (Modiolopsis?) unionoides. It was later placed by Ulrich (1893, p. 677) into his genus Ischyrodonta, and its important interior characters made known. Foerste (1914, p. 298), has pointed out that this shell is so common in the upper horizons in the Lorraine, that it could not have escaped the attention of the early investigators and he identified Meek's unionoides with Cypricardites curta of Conrad, briefly described but not figured in the fifth annual report of the New York Geological Survey (1841, p. 53), adding that the Modiolopsis curta of Hall, figured on plate 81, figure 4 of Paleontology of New York, volume 1, is a very typical Ischyrodonta unionoides. Conrad's description is so short and noncommittal that Ischyrodonta unionoides might come under it. Hall, however, later (1859, p. 14) reproduced Conrad's original figure of Cypricardites, supposed to be C. curta, his genotype, and this represents the interior of some unknown Cyrtodonta (Bassler, 1915, p. 344). This fact would seem to invalidate Conrad's claim to priority; but then Hall (1847, p. 297) has, as Modiolopsis curta, also described a form from the upper Lorraine of New York, which we believe was intended to replace Conrad's species which Hall did not recognize as properly established. His first figure (op. cit. plate 81, figure 4) is, as pointed out by Foerste, a very typical form of Ischyrodonta unionoides from Grimsby in Canada. According to the rules of priority, this fact should establish it for Hall's name. Hall has, however, also figured as Modiolopsis curta on plate 82, figure *2a* a small individual of Pterinea demissa and in the following figures *2b* and *2c* two more species, and having obviously adapted his description to the Pterinea demissa, this becomes the type of his species (Foerste, p. 299) and thereby also invalidates his species, leaving Meek's term as the only one that will not create confusion.

Doctor Ulrich (1893, p. 677) gives the following description of this species:

> Shell of medium size, subovate, a little the highest posteriorly, compressed convex, thickest slightly above and in advance of the middle. Anterior margin regularly but rather narrowly rounded; base forming a broad semielliptic curve; posterior margin broadly

rounded, very slightly oblique; dorsal outline more or less strongly arcuate, passing gradually into the ends. Beaks small, compressed, projecting very little beyond the hinge margin, placed between one-fourth and one-fifth of the length of the valves behind the anterior extremity; umbonal ridge scarcely distinguishable. Surface showing only a few distant subimbricating marks of growth.

Hinge comparatively weak for the genus, with one oblique cardinal tooth in the right valve and two (?) in the left. The ridgelike internal ligament support leaves a linear depression within the dorsal edge extending posteriorly from the beak for a distance equaling about one-third of the length of the shell. Anterior adductor and pedal muscle attachments having the characters usual for the genus, except that they are with respect to the beaks, more anterior in position for the reason that the anterior end is uncommonly long.

Foerste has observed that the specimens from the uppermost Lorraine at Bennett's bridge, show slight differences which, however, are scarcely specific, from the typical Ischyrodonta unionoides of the Fairmount beds. These consist in an accentuation of the oblique lines, making the shell slightly less rotund.

Our material has not furnished us any specimen that shows the cardinal teeth, but the casts of the interior, found in the weathered drift blocks, often beautifully exhibit the characteristic muscle-scars, including that of the pedal-muscle (see plate 2, figures 1 and 2), just above the inner side of the anterior adductor scar, where it was attached to the under side of the hinge-plate. There is likewise well shown the impression of the wide and strong hinge-plate characteristic of the genus, and the impression of the ridges that surrounded the large and strong anterior adductor muscle on the upper and inner side. The simple pallial line is seen in plate 2, figure 2.

The outline is subject to some variation in our material, but in the whole it has, as noted by Foerste, a tendency to be slightly less rotund than in the western representatives.

I. unionoides occurs in the Bellevue division of the Maysville at Cincinnati and vicinity. It is further known from Weston, near Toronto (Foerste, 1916, p. 68), while Hall's locality Grimsby in Ontario is probably based on an erratic specimen, according to the same author.[1] From New York it has been reported by Foerste from Pulaski a locality between Lorraine village and Worthville and one a short distance below the Salmon River falls. We have observed it in the Lorraine sections at stations 25 and 27 as a common fossil. It would thus appear not to go below our zone VI, but the locality at the road between Lorraine and Worthville mentioned by Foerste, which we believe to be our station 17, would bring it much below that zone. The occurrences at Pulaski, above the railroad bridge, and at the Salmon River falls prove that the species continues to the top of the Pulaski formation. It is a fairly common fossil in the rusty brownish weathering drift blocks of the Lorraine which have furnished a considerable part of the known fauna of the Pulaski formation.

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[1] Miss Stewart (1920, p. 14) has meanwhile cited and figured from the Don brickyard at Toronto a slightly differing form of the I. unionoides group.

Genus **Whitella** Ulrich

Whitella goniumbonata Foerste

This species was first made known by Foerste (1914, p. 301), from the Pulaski beds of the Rivière des Hurons in Quebec. It was obtained by us at station 14 of the Whetstone Gulf section (near base of Pulaski beds). Foerste gives the following description of the species:

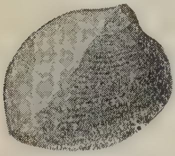

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Figure 7 Whitella goniumbonata Foerste. Right valve. Natural size (From Foerste).

> Shell small, short, subrhomboidal. Beaks nearly terminal, enrolled toward the hinge-line so as to produce a concave anterior area 11 mm long along the anterior margin, and 2 mm in width on the single valve. Present convexity of the single valve about 5 mm but the original form of the shell probably was more ventricose, producing a more prominent umbonal area and a greater width for the anterior concave area. Umbonal ridge, at its junction with the cardinal slope, angular, the angle being sharply defined from the beak for a distance of about 17 mm toward the lower posterior angle of the shell, and then becoming more rounded. Concentric striae rather faintly defined.
>
> The hinge area is not exposed in the specimen at hand. The generic determination is based upon the general appearance of the shell.

We give in the following the measurements of our specimen, which is somewhat obliquely compressed with the corresponding ones of the type after Foerste in parenthesis:

Length 20 mm (24mm), length from the beak along the umbonal ridge to the lower posterior margin 22.5 mm (25 mm); height posteriorly 17 mm (20 mm); height at the beak about 15 (17 mm); extension of the shell anterior to the beak about 1.5 mm (2 mm); convexity of the single valve about 4 mm (5mm) in the present state of preservation.

It will be seen that the relative dimensions of our specimen are the same as those of the type, which is a little larger.

Superfamily **Pterinacea**

Family **Pterineidae** Dall

Genus **Pterinea** Goldfuss

Pterinea insueta (Emmons)

Plate 2, figures 4 and 5

Pterinea insueta was first named and figured but not described by Emmons in the Second District Report page 399, as a fossil of the Utica slate occurring in the Mohawk valley. An adequate description was given by Hall in 1847 (p. 291), who states that the fossil occurs in the Utica slate " at Canajoharie, and is not known in the higher part of the group " (meaning the Lorraine).

The black shale of the Canajoharie region was found by the writer (1912, p. 29) to be of Trenton age (Canajoharie shale) and it was held by the writer that P. insueta not having been reported, from the true Utica shale, is a species that is probably restricted to the Canajoharie shale. We have now, however, before us specimens of Pterinea, hardly distinguishable from P. insueta, from the upper Utica shale at Holland Patent, N. Y., the Deer River shale in the Whetstone Gulf and the first zone of the Whetstone Gulf formation in the Wood creek section.

While the specimen from Holland Patent, like the typical P. insueta, represents a broad form, being about as long as high, that from the Atwood shale is distinctly higher than long, and more erect, approaching in this features the later P. demissa.

The form from the Deer River shale (plate 2, figure 4) is 20 mm long measured along the umbonal ridge, 22.5 mm along the hingeline, but only 17.5 mm between the anterior and posterior margins (length). The anterior ear is short and rounded, the posterior wing, judging from the course of the growth-lines, was but little extended. The surface, near the basal margin, exhibits faint radial wrinkles. This mutation principally distinguished by its more erect outline, will be termed *mut. bursa.* It has been cited as P. insueta *mut. nov.* in part 1 of this study, Bulletin 258, p. 46.

Pterinea (Caritodens) demissa (Conrad)

Plate 2, figures 7–11

Conrad (1842, p. 242) briefly described this species as Avicula demissa illustrating it by the figure of a young individual and citing the " lower Silurian sandstone," near Rome, Oneida county, N. Y., as the type locality. A mature specimen, from the " lower part of the grey sandstone " was at the same time figured by Emmons (1843, p. 404, figure 2). Through the liberality of Professor H. F. Cleland of Williamstown, Mass., this specimen is now in the New York State Museum. Hall (1847 p. 292, plate 80, figures *2a*, *2b*) redescribed and refigured the species, recording its occurrence also in the " Hudson River group " of Ohio, and in the drift. It was still more fully described by Hall and Whitfield (1875, p. 78) from western material, the description and figure, however, based on a rather broad individual that does not represent the typical expression of the species.

The mode of growth, hinge-structure and range and distribution have more recently been very fully elaborated and discussed by Foerste (1910, p. 71; 1914, p. 269), who proposed the genus Caritodens for forms which differ from the genotype of Pterinea (P. laevis) in the absence of a well-defined, longitudinally striated ligamental area, but later discovered, with more perfect material, that the shell consists of two layers, a thin outer and a thick inner layer, and that the supposed absence of a ligamental area is due to the preservation of the outer layer only. In the more perfect material this author has found a peculiar hinge-structure, consisting of a " lunate callosity or thickening (which he calls jugum) of the interior of the shell a short distance below the ligamental area, the concave side facing the middle parts of the valve, the posterior extension curving away from the ligamental area, following approximately the line of junction between the body of the valve and the posterior wing, while the anterior crural ridge or anterior part of the jugum extends for only a short distance along the line of junction between the body of the valve and the anterior ear." " Between the inner edge of the jugum and the lower margin of the ligamental area the shell is thickened" "and transverse to this thickening, below the beak, there are several ridges serving as anterior cardinal teeth," while " the posterior extension of the jugum serves as a posterior lateral tooth."

It is obviously on this peculiar hinge-structure, an approach to which is seen in Pterinea flabellum Hall according to Foerste, that the genus Caritodens has now to be based.

The outline of the shell, which was described by Hall as " obliquely subovate," is subject to interesting changes in the individual growth of the shell, a few of these stages are illustrated by figures 8–10. While the earlier stages are longer than high, the maturing shells become increasingly higher than long. According to Foerste (1914, p. 269) this marked change in outline takes place in the following way:

With increasing age the sinuosity of the anterior margin of the shell becomes more pronounced, the angle between the anterior margin of the ear and body increasing from less than 25 to frequently more than 55 degrees. This is due chiefly to a retardation of growth of the anterior margin of the body below its junction with the ear, and an acceleration of growth along the basal margin. A similar retardation of growth takes place along the line of junction of the posterior margin of the body with the wing. The result is that the anterior margin of the body becomes more erect, the shell is strongly prolonged in the direction of the basal margin, assuming a more oblong form, and the general appearance is that of a less oblique shell. In the meantime there is a considerable prolongation of the shell along the hinge-line, both anteriorly and posteriorly, these parts, usually however, not being well preserved.

Foerste figures a young specimen showing the strong prolongation of both the anterior ear and posterior wing. It would seem that, while there is some variability in regard to these extensions of the cardinal line, the Lorraine material lacks the tendency shown in the Richmond forms to the strong development of the ear and wing, for even where the extremities of both are not preserved, the growth-lines by their curvature indicate but blunt extensions.

Hall and Whitfield observed that the regular, concentric, lamellose lines that mark the surface are sharply elevated, giving exceedingly roughened character to the surface. This feature of the species is also very well shown in casts of the exterior occurring in the Lorraine rocks. Foerste suggests that, judging from well-preserved specimens observed by him in clays of the Richmond formation, on the Nicolet river, the sharp striae may have served as lines of support for narrow lamellose extensions of the shell, .5 mm or less in width. A cast of the exterior in the Museum collection, that retains the thin cavities corresponding to these extensions, corroborates this inference.

The posterior muscular scar is described by Foerste as large and lying a short distance below the termination of the posterior lateral tooth. Figure 7 shows its faint impression in a cast of the interior surface. The faint pallial-line is also shown in the same figure. The anterior muscular scar, of which Foerste could not find any trace, must have left a still shallower impression. There is a faint subcircular outline noticeable in the specimen mentioned above, that probably indicates the location of the anterior adductor muscle; and a smaller specimen shows a distinctly outlined small oval area, at the anterior base of the umbo.

The left valve is strongly convex, rounded and thickest in the center, but flattened and slightly concave toward the alations, and depressed convex on the umbo. The beak is small and extending but little above the hinge-line. The right valve is frequently as thick as the left, but is only slightly convex toward the beak, and becomes flattened toward the basal parts. It is a peculiar fact that the great majority of specimens found in the Lorraine are left valves; and so are all found figured in the literature, the others possibly having been less resistant.

Caritodens demissa has a long range and wide geographic distribution. It is found in the Maysville and Richmond groups and over an area extending from Indiana, Kentucky and Tennessee to Quebec and Ontario. Foerste (1914, p. 274) points out that it is much more common in the Richmond than in the Lorraine. Apparently it also attains larger size and more luxurious development of the ears and wings. In the New York sections we have observed it at Pulaski; both below and above the railroad bridge, at stations 28 and 31 of the Lorraine gulf section and at station 14 of the Whetstone gulf section (zone V). It thus appears to range throughout the whole Pulaski formation, but to be absent in the Whetstone gulf formation, corresponding to its absence in the western Eden. The species is a rare fossil in our Lorraine and the best specimens are obtained in the drift material from the calcareous sandstone ledges of the upper Pulaski.

Pterinea obtusiformis Ulrich MS.

Plate 2, figure 6

The Whetstone Gulf formation has afforded in the Wood creek section (station 1) a form of Pterinea, that Doctor Ulrich considers as identical with his manuscript species of obtusiformis.

The specimen is an erect, subrectangular shell, 19 mm high and 16+ mm long, the anterior margin being not fully preserved. Its posterior wing apparently was also but little or not extended. The surface is marked, besides the concentric striae and flat interspaces, by some very prominent concentric wrinkles and the obscure radiating (interior ?) wrinkles extending from the umbo to the basal margin along the middle of the shell, which is fairly convex. This form can be distinguished from the preceding one by the coarse concentric wrinkles and greater convexity of the body of the left valve.

The obscure radii appear in the best preserved specimens as low wrinkles upon the umbo, but towards the posterior margin fade out into shallow grooves. The posterior wing is in one specimen provided with very fine shadowy radiating lines. The cardinal area has not been observed; in one specimen, however, a faint wide ligamental area is seen to extend the full length of the posterior wing.

Family **Ambonychiidae** Miller

Genus **Byssonychia** Ulrich

Byssonychia radiata (Hall)

Plate 3, figures 1–3

See part 1, Bulletin 258, plate 6

Byssonychia radiata was separated by Hall (1847, p. 292) as Ambonychia radiata from Ambonychia carinata (Goldfuss). The latter form had been described as Pterinea carinata in the Petrefacta Germaniae, 1826, from the "Graywacke" of Lewistown, Oneida county, N. Y. With it had been identified by Emmons (1842, p. 402) and Vanuxen (1842, p. 64) the common radially ribbed lamellibranch of the Lorraine beds. Hall separated his species on the ground that B. carinata is a larger form and has relatively less plications (about 24) as against 35 to 40 on B. radiata.

The new species was fully figured and described by Hall, (op. cit.) and in later publications (Palaeontology of New York, volume. 3, 1859, p. 269, 523) the same author added, from western specimens, the description of the muscular impression, pallial line and hinge teeth, and also noted the byssal opening.

Ulrich then (1897, p. 498) made the species the genotype of his genus Byssonychia, which differs from Ambonychia principally in the presence of lateral teeth and a byssal opening.

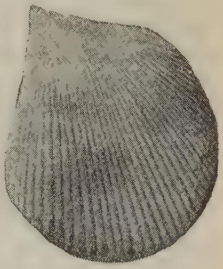

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Figure 8 Byssonychia radiata (Hall) Type, natural size. (From Foerste.)

The species has been fully discussed by Foerste, (1914, p. 273). He regards the original of Hall's figure 4*a*, which came from Pulaski as the type of the species; and 4*b*, from an unknown locality as a cotype; and makes the following remarks on the species.

> Figure 4*b* comes nearest to presenting the correct outline of the shell, especially those with the average number of plications. The upper part of the anterior margin is slightly concave, owing to the forward curvature of the shell at the beak and the incurvature of the anterior face of the shell toward the byssal opening. The upper part of the umbonal ridge is never angular as in B. richmondensis. The angle between the anterior face and the cardinal

margin usually varies between 85 and almost 90 degrees, but occasionally is as low as 80 degrees. The length of the cardinal margin usually is about half the greatest length of the shell, from the beak toward the posterior part of the nearly evenly convex basal margin. Occasionally the cardinal margin equals about three-fifths of the greatest length of the shell. The ratio of the greatest width to the greatest length, measured diagonally across the shell from the beak to the posterior part of the basal margin, usually is about 77 per cent. but may vary from as low as 70 to as high as 81 per cent. The convexity of the single valve usually does not exceed 6 mm in a shell having a maximum length of 36 mm. Shells exceeding 40 mm in length are rare. The number of radiating plications appears to vary considerably. If only those shells are selected in which both the cardinal margin and the anterior face are well exposed, then 45, 46, or 47 radiating plications are very frequent. Specimens, however, occur in which the number of plications is as great as 55. In the specimens with 45 radiating plications, these plications are distinctly broader than the intervening grooves in those with 55 plications, the width of the latter exceeds that of the intervening grooves, only slightly, if at all. Since the number of plications is considered as of diagnostic value in the genus Byssonychia, an attempt was made to discriminate two species among these Lorraine forms from Pulaski, but without success. At Pulaski specimens with about 45 plications are rather abundant, both in the gorge south and southwest of the town, and also along the river banks eastward, as far as the railroad bridge. Specimens with 55 plications occur, associated with the others, at the Trinucleus horizon, several hundred yards west of the railroad bridge.

The statement by Hall that Byssonychia radiata has 25 to 40 plications probably indicates that he had specimens with 45 plications in his possession, those on the anterior face not being well exposed. The specimen illustrated by figure 4*a*, in plate 80, of the Palaeontology of New York, volume 1, was found to possess 48 radiating plications.

Specimens from the calcareous sandstone of the Pulaski exhibit the hinge-structure very well as impressions, the teeth becoming visible when the beak is broken away. It is thus found that the large single tooth in the right valve (plate 3, figure 3) is wedged-shaped, the sockets for the opposite teeth are flanked by narrow sharp ridges, for the posterior one of which at least there is again provided a depression on the opposite side, making a sort of auxiliary tooth of it. The two teeth of the left valve are slightly curved. The lateral teeth number usually three. The cartilage band is relatively broad and shows as many as seven grooves. Also the posterior adductor muscle, with an additional impression for the pedal muscle, and the pallial line are sometimes seen in interior casts (plate 3, figure 1.)

The range of B. radiata is given by Bassler as Maysville and Richmond, and its geographic distribution extends from Anticosti and Quebec to Indiana, Kentucky, Tennessee and Virginia. In New York it is found everywhere in the Pulaski formation, of which it is one of the most common and striking fossils, forming sometimes veritable shell-banks.

Byssonychia vera Ulrich

Plate 3, figures 4-8

The name Byssonychia vera was proposed by Ulrich (1893, p. 629) for a form which in the Cincinnati region was usually confounded with the Ambonychia bellistriata Hall, a Trenton species.

It is very similar to B. radiata, but differs, according to Ulrich, " in its smaller size, finer striae, (there being about fifty to from thirty-seven to forty in the typical form of that species,) shorter hinge-line, more evenly convex valves, and shorter byssal opening."

B. vera is recorded by Bassler as an Eden form of Cincinnati, Ohio and vicinity and as also occurring in the upper Trenton of Rogers Gap, Kentucky, where Foerste has found it. The latter author has since (1916, p. 88) also reported it from beds of Eden age on Manitoulin island, and Stewart (1920, p. 25), from Toronto, Ont.

In New York we have found it throughout the Whetstone Gulf formation, although showing some variation from the typical form of Cincinnati, both in size and relative length of hinge-line, some individuals (see plate 3, figure 4) reaching the size of an average B. radiata and others fully equaling that species in the relative length of the hinge-line. At the other hand, all Byssonychias of the Whetstone Gulf formation show a decidedly larger number of ribs and more even convexity of the valves than the later B. radiata. Foerste (1914, p. 274) has pointed out that in B. radiata the typical number of ribs is about 45 to 47, but that one also finds specimens with as many as 55 plications. This is fully corroborated by our observations. In the B. vera of the Whetstone Gulf formation 55 or more ribs are found quite regularly and the number of ribs is always greater than in the typical radiata. Another reliable difference between the two species is that in B. vera the angle between the anterior face and the cardinal margin is always around 80 degrees and smaller than in B. radiata. The ligamental area is relatively wider than in radiata and furnished with about seven striae.

In a form that occurs at station 3 of the Wood creek section (zone I of the Whetstone Gulf formation) the number of plications is 65, while at the same time the width is about one-eighth greater than in the typical vera. We will distinguish this small variety as B. vera var. pluricosta.

Byssonychia carinata (Goldfuss)

Goldfuss, in the Petrefacta Germaniae (1826, p. 136) described and figured as Pterinea carinata a fossil from the " Graywacke of Lewistown in Oneida county." With this species Emmons and Vanuxem, in the reports on the second and third districts of the first survey of New York, identified the common Byssonychia of our Lorraine rocks, which in 1847 was separated by Hall from the longer known Pterinea carinata as Ambonychia radiata. At the same time Hall also redescribed and refigured the Ambonychia carinata from specimens that he had observed in the drift, giving the " Hudson River group " as the horizon.

Later collectors, the present one included, have never been able to find this species in our Lorraine beds and Doctor Foerste has for that reason critically investigated the status of the species (1914, p. 324) and arrived at the conclusion, that the form is nearest to or probably identical with B. richmondensis and that both Goldfuss' and Hall's specimens came from drift blocks of the Canadian Richmond, Lewistown, in Oneida county, probably being meant for Lewiston in Niagara county, where much drift occurs. Search by the writer in the old gazetteers of New York for a Lewistown in Oneida county has failed in producing such a locality name, and on the other hand, Whitfield and Hovey state that Hall's cotype of the species also came from drift on the south side of Lake Ontario.

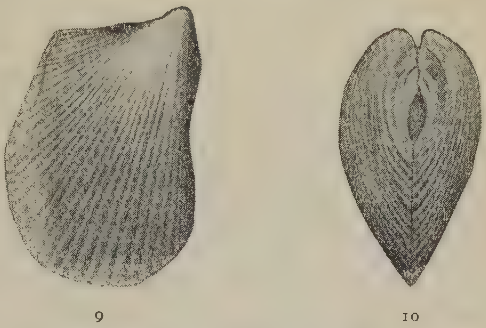
Doctor Foerste therefore is undoubtedly justified in concluding that " it seems best to discard the use of Goldfuss's name, unti more is known regarding this type."

Byssonychia praecursa Ulrich

In volume VII of the Geology of Ohio (1893, p. 633) Doctor Ulrich has described as Byssonychia praecursa n. sp, or var., a form that is there recorded as occurring in the Lorraine shales, Lorraine, N. Y., also in the equivalent middle beds of the Cincinnati group, at Covington, Kentucky, and Cincinnati, Ohio.

It is described as being very much like B. radiata in the number of costae and in the outline. "As a rule, however, the latter is a little more oblique, the hinge shorter and the central part of its valves a trifle wider. But the principal difference lies in the flattening of the anterior side in B. praecursa."

The number of costae is given as varying from 38 to 42; while, in a footnote that of the Cincinnati form of radiata is stated to vary between 36 and 40. Foerste (1914, p. 274) has claimed that the New York form of B. radiata has a greater number of costae, 45 to 47 being the more frequent number. Our material corroborates this view as to the greater number of costae. On a beautiful slab from Pulaski, covered with specimens with this greater number, there is, however, a single specimen which at once attracts attention by its coarser ribs and more elongated form. This shows about 38 costae, separated by interspaces as wide as the costae, a straight anterior face, that is markedly longer than in B. radiata and a more elongate form than the great majority of the specimens of B. radiata possess. The ratio of the greatest width to the greatest length is 71 per cent, as against 77 per cent, usually found in B. radiata, width variations to 70 and 81 (Foerste) and against 63 per cent in Ulrich's type specimen of praecursa. It would thus seem that while this Pulaski specimen is not a typical B. praecursa, it certainly is nearer to that species than to B. radiata and probably connects the two.



Figures 9 and 10 Byssonychia praecursa Ulrich. Figure 9 Cast of interior of right valve. Figure 10 Anterior view of same. Natural size. (From Ulrich.)

Byssonychia hyacinthensis Foerste

Plate 3, figure 9

Foerste (1925, p. 163) has distinguished as B. hyacinthensis a form from B. vera occurring along Yamaska river at St Hyacinthe, Quebec, that is distinctly broader, has the umbonal part more broadly rounded, beak less elongate, general outline more rotund, and anterior outline not so straight.

The Whetstone Gulf formation has afforded at station 8 of the Wood creek section a form that in general outline and dimensions well agrees with hyacinthensis. It has 55 ribs.

Superfamily **Mytilacea**

Family **Modiolopsidae** Fischer (emend.)

Genus **Modiodesma** Ulrich

Modiodesma modiolare (Conrad)

Plate 4

See also Part 1, Plate 6

Like many other Paleozoic fossils of New York, this species was first briefly described but not figured by Conrad (1838, p. 118) and given standing by a fuller description and good illustrations by Hall in the Paleontology of New York volume 1, p. 294. Having a wide distribution, it has since been described and figured in many publications. A very precise definition, from a reexamination of the types and other typical material has recently been furnished by Foerste (1924, p. 183), whom we quote:

> Ventral margin forming angle of 10 to 17 degrees with hinge-line moderately convex or nearly straight, never incurved. Anterior margin and lower posterior margin rather rapidly rounded; posterior margin forming an angle of about 130 to 135 degrees with hinge-line, curving strongly toward front on approaching the latter. Valves relatively flat. Beak low and closely appressed, located a considerable distance back from the anterior margin. Umbonal parts rather strongly flattened, but not depressed into a mesial sinus. Surface with concentric striae more distinctly developed anteriorly than along posterior margin.

Horizon and locality. Conrad's type came from Pulaski, N. Y. Hall knew the species to occur in " the central and higher parts " of the Lorraine at many localities. He cites Turin, Boonville and Martinsburgh, Lewis county; Lorraine; Pulaski; Washingtonville near Rome and other places in Oneida county. He has also collected it in Ohio and Indiana. Foerste (1914, p. 283) found it at Pulaski below the railroad bridge at several horizons, and the writer also above the bridge, as well as below the village (zone III); further at Barnes Corners, Worthville, and Salmon River falls. According to Bassler (1916, p. 816), it occurs, besides in New York and Ohio, also in Pennsylvania and Virginia.

In the Lorraine gulf the species occurs at stations 21a, 25, 26, 27, 27a and 28; in the Whetstone gulf section at station 14 and in the Wood creek section at station 14. It thus ranges throughout the Pulaski formation in New York and probably goes also into the next zone below. Foerste has not recorded it from either Quebec or Ontario east and thus while common in some of our Lorraine beds, it does not appear to have passed the Frontenac axis. The form from the Don brickyard near Toronto, referred by Miss Stewart to this species, is considered a different one by Foerste (1924, p. 191).

Remarks. This characteristic Lorraine lamellibranch was first placed by Conrad (1838) and Emmons (1842) under Cypricardites and by Hall made the type of his genus Modiolopsis (1847). Hall, however, conceived his species too wide; considering it very variable he united under it Conrad's species Cypricardites modiolaris, C. angustifrons and C. ovatus, all three Lorraine forms. Ulrich, on finding that these are not only specifically different but that C. modiolaris and C. ovatus represent groups of forms of generic importance, has restricted the genus Modiolopsis to M. ovatus and its many relatives and for the smaller group of forms, of which M. modiolaris bears the typical expression, proposed the new genus Modiodesma. The complex reasons for this selection are fully set forth in the chapter on Modiodesma by Ulrich in Foerste's Upper Ordovician Faunas of Ontario and Quebec (1924, p. 183–90).

According to Ulrich it appears from a survey of Hall's figures and of a collection of specimens of Modiolopsis modiolaris, that there are principally two groups comprised under that term, one where the shells are provided with a mesial depression and ventral sinus and a deeply impressed anterior muscular scar and another which lacks these features. It is clear from Hall's generic description of Modiolopsis that he had the former group in mind in drawing it up. This, as represented by Cypricardites ovata is therefore made the genotype of Modiolopsis and the term Modiodesma proposed for the form with the mesial depression and marginal sinus so little developed that the ventral edge remains more or less convexly curved throughout. Also the beaks are usually farther removed from the anterior extremity than in Modiolopsis. Hall's figures 1*a*, 1*b* and 1*d* of plate 81 in volume 1 of the Palaeontology of New York represent Modiodesma modiolare. Figure 1*a* is Conrad's type of Cypricardites modiolare and the holotype of Modiodesma modiolaris. Fig. *b* (*ibidem*) represents the type of Cypricardites angustifrons Conrad and is considered by Ulrich as a variety (angustifrons Conrad) of Modiodesma modiolare, and 1*d* is the figure of still another variety (brevior Ulrich), while 1*c* illustrates a western form (Modiolopsis halli Ulrich) and 1*e* is the Modiolopsis ovata that is made the genotype of Modiolopsis.

Modiodesma modiolare (Conrad) var. **angustifrons** (Conrad)

Conrad's species Cypricardites angustifrons is considered a variety of Modiodesma modiolare by Ulrich (1924, p. 189). Its distinguishing character is the strong narrowing of the anterior extremities, continued with a lesser one of the entire shell and a more forward position of the beaks. Hall's figure 1*c* of plate 81, volume 1, Palaeontology of New York, represents the typical expression of this form. It is principally found in the drift, derived from the upper calcareous Pulaski sandstone.

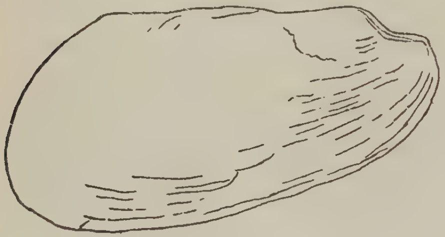


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Figure 11 Modiodesma modiolare (Conrad) var. angustifrons (Conrad). Outline of Conrad's type. Natural size.

Modiodesma modiolare (Conrad) var. **brevius** Ulrich.

Hall's figure 1*d* of plate 81, volume 1, Palaeontology of New York, illustrates a shorter and relatively higher variety of M. modiolare for which Ulrich (1924, p. 189) proposes the name brevior (*recte* brevius). It has not been found by the writer in place and is apparently also derived from the drift.

Genus **Modiolopsis** Hall (emend. Ulrich)

Modiolopsis ovata (Conrad)

Plate 4

This species, the Cypricardites ovata of Conrad (1841, p. 52), is figured by Hall under Modiolopsis modiolaris; his figure 1*e* of plate 81, volume 1, Palaeontology of New York, representing Conrad's type.

The diagnosis of Modiolopsis, furnished by Ulrich (1924, p. 187) and based on this species gives a general brief description of the form and is quoted here:

> Shells with a black epidermis, subovate, widest posteriorly, the dorsal edge very gently convex, the ventral side slightly sinuate. Umbones, though small and rather low, projecting distinctly above the hinge-line, situated near the anterior end and over the inner third of the deeply impressed anterior adductor scar; umbonal ridge rounded, low, notable mainly because of an undefined but wide depression over the antero-ventral slope; cardinal slope gently concave. Surface usually with concentric lines and narrow ribs, the latter strongest, rounded, and not regularly spaced on the posterior half. Hinge-plate thin, with a single, undefined subrostral tooth and socket in each valve; ligament external but lying partly in a very narrow area. Pallial line simple; posterior adductor scar large but very faintly outlined.

Horizon and locality. Modiolopsis ovata is a form of the upper Pulaski shale and found mostly in the drift. On a slab of calcareous sandstone from Oswego county in the State Museum it is seen associated with Modiodesma modiolare.

Modiolopsis anodontoides Hall

Plate 5, figure 1

The synonymy of this species is rather involved. Emmons (1842, p. 399) first figured but did not describe the species as Cypricardites sinuata. Hall in 1847 (p. 298) in referring to the same form termed it Modiolopsis anodontoides Conrad, evidently referring to an unpublished manuscript name and description of Conrad. He cites Cypricardites sinuata as a synonym, stating that the differences in form are due to pressure, Conrad's type being preserved in sandstone and Emmons' in shale.

Hall figures three specimens, all of which are in the New York State Museum. The original of plate 82, figure 3*a*, is Conrad's type. This, here refigured in plate 5, figure 1, is incomplete anteriorly. The second original (plate 82, figure 3*b*) proved according to a label by Hall, "to be the young of Cimitaria recurva, Hamilton group." The third (figure 3*e*), which lately was also found in the State Museum by the writer, is preserved on a slab of black shale from Rodman, N. Y., that is covered with this form, which clearly represents a third different species (see Cuneamya parva). Emmons himself (1855, p. 171) has later relinquished his specific name in favor of Conrad's obviously following Hall in this procedure.

It is now obvious that Conrad's name has no standing and that the species is either to be credited to Emmons or to Hall, the latter having both figured and described the form. As a figure, however, according to the rules of priority adopted by the international biologic societies, constitutes a valid claim, Emmons' name would prevail if it were not for the fact that Hall expressly states in the explanation of his figures on page 298, that figure 3*b* represents the original of C. sinuata. This specimen, however, which thus by Hall's own identification is Emmons' type — and a comparison of the specimen with Emmons' figure supports Hall's assertion — has a label in Hall's handwriting, that it proved later to be " the young of Cimitaria recurva, Hamilton group," Emmons' name thus also becomes invalid and there remains only to credit the species to Hall with the name he borrowed from Conrad.

We then have to base the species on the imperfectly preserved original of Hall's figure 3*a*. Hall's description, being clearly based on this specimen, is essentially correct.

The specimen, slightly imperfect in front, was originally, as restored from the growth-lines (see plate 5, figure 1) 26 mm long, with about 1 mm. missing, and 12 mm high. It is subtrapezoidal in outline, the cardinal and basal margins being nearly parallel, and the posterior margin obliquely truncate. The cardinal margin is straight extending three-fifths of the length of the shell from the beak. The posterior margin is but slightly convex, and bends rather abruptly into the basal margin. The latter, which also is but little convex, converges slightly with the cardinal margin in anterior direction, causing the shell to be highest about halfway between the beak and the posterobasal angle. The basal margin is slightly sinuate below the beak. The anterior margin is incomplete in the specimen, but judging from the course of the growth-lines and a second specimen it was bent upward to the middle where it became angular, curving inward. The beak, also incomplete, was, according to the second specimen, situated far forward, little projecting and little prominent, the highest part of the quite convex shell (4.5 mm high) being along the middle line. The umbonal ridge is very prominent and distinct, with an abrupt decline towards the cardinal margin in the anterior half, this giving the appearance of an umbonal crest (" prominent carina " Hall), which, however, is exaggerated both in sharpness and extent in Hall's drawing. A shallow mesial sulcus is noticeable in the basal half below the beak. The hinge is unknown; the posterior attractor muscle is faintly outlined as indicated in the figure. The surface shows faint growth-lines and some coarser wrinkles.

The species is exceedingly rare as already remarked by Hall. We have before us a complete though compressed specimen from station 22*a* (Worthville) of the Lorraine section. Owing to the compression the umbonal ridge is pressed towards the postero-cardinal angle. The surface of this specimen is furnished, in addition to the sharp growth-lines, with rather regular varices which increase in prominence towards the anterior margin.

The reference of this species to Modiolopsis is not final. Judging from the second specimen, it is quite probable that the species more properly belongs to Rhytimya, for besides the outline and the moderate thickening of the varices toward the front, searching reveals faint radiating lines on the posterior part. The type specimen, however, being preserved in sandstone, does not show any of these finer features.

The type specimen is from the typical Pulaski sandstone and marked "Lorraine, Jefferson county." The other reference by Hall to the shale of the lower Lorraine at Rodman is based on the original of his figure 3*c* and on another species. Our specimen is from station 22*a* of the Lorraine section or from the basal beds of the upper Lorraine or Pulaski formation.

Modiolopsis curta (Hall).

This species described by Hall in Palaeontology of New York, volume 1, p. 297, as occurring in the higher Lorraine beds at Lorraine and in the lower shaly portion at Rodman and near Rome, as well as at Grimsby, Canada and Mineral Point, Wisconsin, has not been recognized as a valid species by Bassler (1915, p. 814). Hall's figures plate 81, figure 4 and plate 82, figure 2*b*, are stated to be apparently of Ischyrodonta unionoides; those of plate 8, figure 2*a* of Pterinea demissa and of plate 8, figure 2*c* of a small Cyrtodonta from Mineral Point, Wisconsin.

Hall's types are in the American Museum of Natural History and were lent to us by Doctor Hovey for examination. It was found that the original of plate 81, figure 4 is a very fine specimen of Ischyrodonta unionoides, but very poorly drawn. It shows the anterior and posterior adductor muscle scars and is 3 mm longer in the direction of the umbonal ridge than drawn. The original of plate 82, figure 2*a* is a small Pterinea demissa, the anterior ear and posterior wing of which are lacking. Figures 2*b* and 2*d* belong together, the specimen being entire and belonging to Cyrtodonta. It is a brown limestone specimen and obviously not from the shale at Rodman, Jefferson county, N. Y., as stated in the explanation of the plate. Whitfield and Hovey (1898, p. 47) give Mineral Point, Wisconsin, as its locality, the same as of the type of figure *2c* which apparently is not any more extant.

Genus **Prolobella** Ulrich

Prolobella corrugata nov.

Plate 3, figures 10–12

Description.— Shell small, obliquely subovate, moderately convex. Anterior end auriculate, small, well-rounded, separated from the rest of the shell by a depression in front of the umbonal ridge. Posterior part somewhat alate and flat along cardinal line. Cardinal margin straight, not quite two-thirds of the length of the shell, passing with a gentle curve into the evenly rounded, oblique posterior margin; which at the postero-basal angle bends into the less convex basal margin. The oblique anterior margin is straight to slightly sinuate beneath the ear. Beaks prominent; umbonal ridge distinct to the postero-basal margin. Surface marked by very strong concentric wrinkles and fine growth-lines, as well as strong radiating striae extending from the umbo to the basal and posterior margins, but lacking on the ear.

Measurements.— Our specimens are small for the most part; the two types here figured measuring 6 mm by 5 mm and 11 mm by 7–5 mm. The United States National Museum contains specimens reaching a length of 18 mm and a height of 11 mm.

Horizon and locality. — In the black shale of the lowest horizon of the Whetstone Gulf formation, north of Rome, N. Y.

Remarks. — This species is in general aspect very near to the Trenton form P. trentonensis Hall, but is smaller, less elongated and less sinuate in the anterior margin.

Genus **Orthodesma** Hall and Whitfield

Orthodesma pulaskiense Foerste

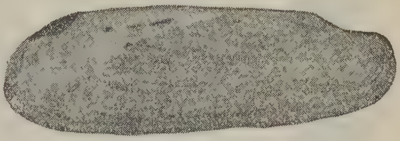
Plate 5, figure 2

Orthodesma pulaskiense Foerste. Bull. Denison Univ., 17, 1914, p. 288, pl. 3, fig. 6.

The original description of this New York form is replaced by a more concise one by Doctor Foerste (1924, p. 194), and this is copied here:

Shell about three times as long as high, enlarging slightly from the beaks toward the posterior end, abruptly narrowed anterior to the beaks. Posterior end obliquely truncated. Umbonal ridge fairly angular near the beaks, diverging at a small angle from the hingeline along the anterior half of its course, amount of divergence increasing along posterior half. The pallial line starts at the lower posterior end of the anterior muscle impression and inclines diagonally downward toward that part of the ventral margin posterior to the mesial sinus. The latter flattens the preumbonal slope and causes a slight depression a short distance posterior to the beaks, producing a faint concavity of outline along the ventral margin.

Doctor Foerste found the species "immediately below the railroad bridge, 1 mile east of Pulaski, New York." We have observed this evidently rare species only in drift material and figure a specimen that is slightly narrower in front and wider posteriorly, but that well shows the angular umbonal ridge and the growth-lines. The species is similar in outline to Cymatonota pholadis (Hall), but distinguishable by the oblique folds along the cardinal line in the latter species.



12

Figure 12 Orthodesma pulaskiense Foerste. Right valve. Natural size. (From Foerste.)

Doctor Ulrich (personal information) has distinguished in the drift material from the Lorraine of New York in the National Museum still other Orthodesmas, namely, O. transitum Ulrich, O. cf. corryvillense Ulrich and O. cf. extensum Ulrich. These forms are in manuscript and will be published eventually in a larger work on Cincinnatian lamellibranchs. Doctor Foerste has also figured (1924, plate 31, figure 11) from the upper part of the Pulaski formation, in the fossiliferous sandstones at the cross road, 1 mile south of Barnes Corners near Lorraine, N. Y., a form with a similar outline to O. pulaskiense, but with the beak nearer the anterior margin, and which may fall under one of Ulrich's unpublished species.

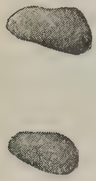
Genus Modiolodon Ulrich

Modiolodon truncatus (Hall)

Hall described as Modiolopsis truncatus in Palaeontology of New York, volume 1, page 296, a form said to occur near Rome, Oneida county, and at Cincinnati. The figures (plate 81 figures 3*a*, 3*b*) are poor but sufficient to show a short, subtrapezoidal outline. A better figure of this type specimen is given by Hall and Whitfield in 1875 (plate 2 figure 13), where the specimen is stated to come from Cincinnati, Ohio; and Whitfield and Hovey, in the catalog of the types in the American Museum (1898, p. 46) likewise record the original of the two figures as coming from Cincinnati.

Ulrich has later (1893, p. 656) placed the species under his new genus Modiolodon and gives two more figures of Cincinnati specimens. The species, as occurring about Cincinnati, is thus well determined in its characters. We have never seen it in the Pulaski rocks of New York, nor has Foerste observed it in Quebec or Ontario east. We therefore doubt that it occurs here.

The remark by Hall and Whitfield (1875, p. 86) that they are strongly inclined to believe that the Anodontopsis (Ischyrodonta) unionoides Meek will prove to belong to Modiolopsis truncatus leaves but little doubt that the specimens from New York, which they had before them and referred to Modiolodon truncatus, in fact belong to Meek's species which is very common in our Lorraine, also about Rome.



13

Figure 13 Colpomya faba (Emmons) mut. pusilla Foerste. Two left valves, natural size. From Pulaski, N. Y.

Genus **Colpomya** Ulrich

Colpomya faba (Emmons) mut. **pusilla** Foerste

Colpomya faba was first figured but not described as Nuculites faba by Emmons (1842, p. 395), a specimen from the basal Trenton at Watertown serving as type. Hall (1847, p. 158) described and figured the species adequately, and also referred to it material from the Lorraine group, stating that it is common "both in the shaly and arenaceous portions of the group," or in other words, in the Whetstone Gulf and Pulaski formations.

Foerste (1914, p. 275) has separated the Pulaski form as Colpomya faba-pusilla.

According to this authority, the valves of C. faba-pusilla when compared with typical C. faba are "relatively higher posteriorly and lower at the beak, owing to the stronger divergences of the basal margins from the cardinal outline, amounting frequently from 30 to 35 degrees. The beak projects more distinctly above the cardinal margin, and the cardinal part of the anterior margin rises more nearly to the level of the straight cardinal outline of the shell posterior to the beak. The mesial sinus begins at the beak as a depression near the middle of the umbones; it tends to be more oblique than in Colpomya faba, but as a matter of fact, the Lorraine form is scarcely distinguishable from the Trenton types.

C. faba-pusilla is recorded by Foerste as occurring at Pulaski below the railroad bridge, at the eastern edge of Lorraine village and at the road crossing over the creek, 2 miles west of Worthville, and at Chambly in Quebec. He has not found it at the higher horizons of Pulaski at Bennetts bridge and the Salmon River falls. Our observations have corroborated this result, for we have failed to collect it in the Lorraine section above station 25, or in stations 26 to 32, corresponding to the greater part of zone VI and to zones VII and VIII. Specimens are also not infrequently seen in the drift-blocks of brown-weathering gray calcareous sandstone. Miss Stewart (1920, p. 29) has recorded it from rocks of Pulaski age at Toronto.

Colpomya faba (Emmons) mut. **intermedia** nov.

Plate 5, figure 9; plate 20, figure 6

Foerste's eleborate description (1914, p. 275) of the Pulaski mutation of the Trenton species Colpomya faba enables us to characterize the Whetstone gulf mutation by simply pointing out its distinguishing features from both the Trenton types and the Pulaski mutation.

The specimens of the Whetstone gulf shale, while attaining a length equal to that of the Pulaski form, and also a posterior height, that as in the latter form, is somewhat greater than half the length (the usual proportion being 5:3) are relatively higher in front, at the beak, the height here being half the length, but usually a little more. The Whetstone gulf forms thus approach the typical Trenton form in the lesser difference between the anterior and posterior heights, or rather are intermediate between the two. The posterior margin, with rare exceptions, is very little oblique and well rounded; the length of the straight hinge-line therefore very considerable, amounting to one-half the length of the valve or more. The umbonal ridge is as in pusilla, the mesial sulcus equally strongly defined, but frequently less oblique, 70 degrees or more being an average angle, formed by the sulcus with the cardinal outline. The beak projects hardly more beyond the cardinal line than in typical faba.

Doctor Ulrich has pointed out to me that C. intermedia has not as strong a dorsal depression as C. pusilla, but stronger than C. faba.

In one specimen, 10 mm long, the anterior height is 5 mm, the posterior 6.5 mm; in another 9 mm long, the anterior height is 3.5, the posterior 5 mm; in one 8 mm long, the anterior height is 3.8 mm; the posterior 4.2 mm; in one 6.5 mm long, the anterior height is 3.5 mm, the posterior 3.7 mm; in a small specimen but 5 mm. long, the anterior height is 2.8 mm, the posterior 3 mm.

It is obvious that this mutation is intermediate in its character between the typical Trenton form and the Pulaski mutation C. pusilla.

Nevertheless, one finds already in the lowest Whetstone gulf, of Economy age, specimens that could be properly placed under C. pusilla, and on the other hand, others that are more similar to the Trenton forms than the average material from which this mutation has been characterized.

The surface is not only provided with extremely fine growth-lines, but also with equidistant varices or projecting edges, separated by about five of the finer growth-lines; and in one finely preserved specimen there can be seen also extremely delicate radiating lines on the posterior umbonal slope.

This mutation has been observed at stations 6,9–10, 12–13, 14, 15–16, 20 and 21*a* of the Lorraine gulf section, stations 5,9,10–11, 12 and 13 of the Whetstone gulf section; stations 10, 12 and 15 of the Mill creek section; 11–12 of the Moose creek section; and stations 4, 8, 9, 10 and 12 of the Wood creek section. It is further common among the black Lorraine shale material in the Rust collection from the neighborhood of Rome. Practically all the Colpomya faba of the Whetstone Gulf formation can hence be placed under this mutation.

Genus **Whiteavesia** Ulrich

Whiteavesia nasuta (Conrad)

Plate 5, figures 3–6

This species was first very inadequately described by Conrad (1841, p. 52) under the name of Cypricardites nasuta as follows: "Narrow, subelliptical; anterior side rostrated, acute; posterior margin very obliquely truncated." As locality is given, Rome, Oneida county. Conrad did not figure the species, the first figure being given by Emmons (1842, p. 403, figure 4) who however having failed to recognize Conrad's species, identified this charactestic fossil of the upper Pulaski with Modiolopsis modiolaris. It was, as in most of Conrad's species, Hall's description and figure (1847, p. 296) which gave the name standing. Hall recorded the species as occurring only in the arenaceous strata of the higher parts of the "Hudson River group", the principal localities being near Rome and Lorraine, N. Y.

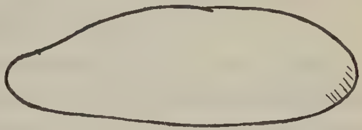
The species has, since Hall's description, been left unnoticed with the exception of its reference to Orthodesma by Clarke and Ruedemann (1903, p. 468) until Foerste in 1914 (p. 286) discussed its characters and horizon very elaborately.

The same author has lately, (1924, p. 194), furnished a more concise description, which we quote:

> Outline oblong, dorsal and ventral margins subparallel, rapidly rounded, and abruptly narrowed anterior to the beaks, in a direction at right angles to the length, anterior portion of hinge-line much lower than posterior. Upper part of the posterior margin broadly and obliquely curved, rounding evenly into the posterior end of the hinge-line.

Ulrich (personal information) places the form under Whiteavesia, and it has been cited under that generic designation in part 1, Bulletin 258.

We have figured here several specimens, partly to show slight variations in the outline and the strength of the concentric wrinkles, and partly to show the location and size of the faint anterior and posterior adductor muscles (plate 5, figure 5). Two of these are old Museum specimens, labelled "from Talcott's quarry" near Rome and hence presumably from Conrad's original locality. We also have inserted a tracing of Foerste's photograph of Hall's type, since this is the first specimen figured, although a defective one, as pointed out by Foerste.



14

Figure 14 Whiteavesia nasuta (Conrad). Outline of Hall's original in vol. 1, pl. 81, fig. 2. Natural size.

Foerste observed the species at Bennett's bridge, but not in the highest Lorraine beds within a short distance of the base of the Salmon River falls; he also found it about a mile south of Barnes Corners, and at Worthville, the best specimen being collected about 2½ miles east of Worthville. It was not found at either Lorraine village or Pulaski and its horizon is distinctly above that exposed at these villages. We have collected the species at stations 27*a*, 27*b* and 28 of the Lorraine section; it is thus a member of the faunules of our zone VII and the base of zone VIII. Its absence in the middle and upper part of zone VIII corroborates Foerste's observation of its absence in the uppermost Lorraine beds. The latter author (1916, p. 68, 75) has recorded also its occurrence in the Lorraine beds at Weston, near Toronto, Ontario, and Miss Stewart (1920, p. 38) in the neighborhood of the Humber river near Toronto.

Genus **Pholadomorpha** Foerste

Pholadomorpha pholadiformis (Hall)

The aberrant species of Cincinnatian lamellibranchs, principally characterized by the transverse plications of the surface, which now passes under this name, was first described and figured by Hall as Modiolopsis pholadiformis from the western side of Lake Michigan, in the Report on the Geology of the Lake Superior Land District, 1851, p. 213. It was more fully described from less distorted material and a better figure furnished in 1875 (p. 85) by Hall and Whitfield. Ulrich (1897, p. 514, 1893, plate 56) made known its hinge-structure, referring it to his genus Actinomya, which name on being found to be preoccupied, was changed by the same author to Whiteavesia. Finally Foerste (1914, p. 277) furnished a very elaborate discussion of the character and distribution of the species proposing to separate under Pholadomorpha forms in which " the plications along the basal margin are broad, and more or less transverse to the longitudinal axis of the shell, and posteriorly are more or less divergent from the umbonal ridge." In 1916 (p. 332) the same author supplemented his former work on the species by showing that half a dozen Richmond species of lamellibranchs are synonyms of the Pholadomorpha pholadiformis, being based on more or less crushed specimens or young individuals. If we add that Bassler (1915, p. 967) does not recognize the new genus Pholadomorpha, a brief account of the vicissitudes of this species and its name to the present time is given. To Foerste's elaborate description, published in 1914, has been added a more concise and accurate one by the same author in his last publication (1924, p. 197), which we quote:

> Outline longitudinally oblong ovate, ventral margin diverging from the hinge-line at a moderate angle, varying around 15 degrees. Beak broad, projecting but slightly above hinge-line. Anterior to the beak, the upper margin rises to the same height as the hinge-line posterior to the same. The anterior margin extends about one-fifth of the length of the shell in front of the beak, rounding into anterior part of the hinge-line with only a moderate increase in its convexity. General surface of the shell comparatively flat, umbonal ridge being weakly defined, except near the beak. Slope beneath the umbonal ridge more or less vertically plicated. Above the

umbonal ridge, especially toward the upper posterior margins, the plications tend to be diverted diagonally backward and upward.

P. pholadiformis has its principal distribution in the Richmond beds about Lakes Michigan and Huron, and in Ohio and Indiana. Doctors Ulrich and Foerste (Foerste, 1914, p. 252; 1916, p. 7) discovered this species in the uppermost Lorraine beds at Bennett's bridge, and below the Salmon River falls, in Oneida county, N. Y., in association with Ischyrodonta unionoides, etc. Later Foerste (1915, p. 240, 241) recorded its occurrence in rocks of late Lorraine and Richmond age in Quebec and Ontario east and west. In New York we have not observed it outside of the localities announced by Foerste. It thus seems that it is found only in the last stage of the Lorraine and its principal range is in the Richmond.

Pholadomorpha nasuta Ulrich M S.

Plate 5, figures 7 and 8

While P. pholadiformis occurs in the last stage only of the Pulaski formation and has its principal distribution in the Richmond it is preceded in our Lorraine sections by closely related forms. One of them has been identified by Doctor Ulrich with his manuscript species Pholadomorpha nasuta.

Judging from the specimen here figured, the species is distinguished from the genotype by its longitudinally oblong outline, the small divergence of the ventral margin from the hinge-line (about 10 degrees.) The anterior margin extends relatively as far in front of the beak and rounds more sharply into the ventral margin. The general surface of the shell is more convex and the umbonal ridge well defined. Plications as in the genotype. The holotype measures 57 mm in length, 21 mm in greatest posterior height and 5 mm in convexity.

Horizon and locality. Upper Pulaski beds, at stations 28 to 32 of the Lorraine section, representing our zone of Pholadomorpha nasuta, the last zone observable in the Lorraine gorge section.

Remarks. The holotype would suggest the possibility of its having been slightly compressed in dorso-ventral direction; were it not for the regular oblique and undisturbed course of the umbonal ridge. Another larger especimen (plate 5, figure 8) has an equally extended but less contracted anterior part and recalls in this character as in its outline, as far as preserved, P. chambliensis Foerste which occurs in the Proetus zone of the Lorraine in Quebec and probably in New York. The posterior margin which is less oblique in that species than in P. pholadiformis is not preserved in our specimen.

Genus **Cymatonota** Ulrich

Cymatonota pholadis (Conrad)

This species was first described but not figured by Conrad (1838, p. 118) as Pterinea pholadis. His description is " shell profoundly elongated, ventricose, dorsal and basal margins parallel; posterior side rugose, or with short undulations near the dorsal margin. Length 1¾ inches." As locality, the Lorraine shale at Pulaski is given. Hall (1847, p. 299) cites Conrad's description and copies his figure, stating that he never saw the specimen. Ulrich (1893, p. 663) has identified a form, with some doubt, with Conrad's species, and this doubt is also emphasized in Bassler's Bibliographic Index, p. 338, in citing the Maysville of Cincinnati as possibly containing this species. Foerste (1914, p. 292) pointing out that C. pholadis came from the same locality as Hall's similar species C. parallela, and that specimens referred to the latter species are common while no other specimens having the extreme elongation of pholadis have ever been found in New York subsequent to the original description, suggests that Conrad's description of C. pholadis was based on an aberrant or merely compressed specimen of Hall's species C. parallela. While Conrad's type is 5½ times as long as high, and Hall's type of parallela is a little more than 3 times as long as high, a number of specimens of C. parallela before us average 4 times as long as high, none ever approaching pholadis in relative length. Also the specimen figured by Foerste (1914, plate 1, figure 14) as C. pholadis is only 4 times as long as high. Miss Stewart has figured a shell of similar relative dimensions from the Don brickyard at Toronto.

Cymatonota parallela (Hall)

Plate 6, figures 1–5

Hall (1847, p. 299) distinguished his species Orthonota parallela from the O. pholadis Conrad by its less extended form and greater width, the latter being stated to be fully one-third the length but, as pointed out by Ulrich (1893, p. 663), "he includes two or three distinct forms." Cymatonota pholadis having been rejected in the preceding chapter as being based on an abnormal or compressed specimen that is lost, the question arises from Ulrich's remarks whether Hall's species is based on a better foundation. This question has been answered by Foerste (1914, p. 292) who by re-examining Hall's types in the American Museum found that the original of his figures 7*a* and 7*d*, a worn internal cast according to Whitfield and Hovey (1898, p. 47), is an Orthodesma from Cincinnati, that need not be considered and that only his figure 7*c* is serviceable as type. This and the original of figure 7*b*, a cardinal view, come from Pulaski, (Whitfield and Hovey, ibid.), where like specimens are not difficult to obtain and occur (Foerste, p. 292) a short distance below the railroad bridge, in the same rock slab with Modiodesma modiolare, and Ischyrodonta unionoides, and continue to be found for several hundred yards westward, where they occur associated with Cryptolithus. Hall's description is furthermore distinctly based on specimen 7*c*, so that the species if emended to include only forms of the character of this specimen will be clearly defined.

The characters of this species are the following:

Shell of small to medium size, elongate, with the dorsal and ventral margins slightly diverging, the shell widening slightly in posterior direction, the length 3½ to 4 times the anterior height, the posterior height is greater by about one-tenth than the anterior, the thickness about one-half the height; anterior end short, rounded; cardinal margin straight, posterior margin rounded below, oblique in upper part; ventral margin straight or but very slightly convex. Beaks appressed, scarcely prominent, situated one-fifth of the length of the shell behind the anterior extremity. Umbonal ridge distinct anteriorly, but becoming more rounded posteriorly. Surface, in shale specimens, with fine, very regular, filiform growth-lines which are distinct in front of the umbonal ridge, behind the latter, however, become bunched and form oblique folds or undulations along the hinge-line. Anterior adductor muscle scar small, near anterior extremity; posterior scar very faint.

Horizon and locality. Hall records the species from the soft shaly portions of the Lorraine at Pulaski and other places, and as also occurring in the ferruginous sandstones in the higher parts of the group. Foerste found the species at Pulaski, below the bridge, as already noted before; and the writer observed it there also in the higher beds above the bridge. Foerste did not find it in the uppermost horizons of the Lorraine at Bennett's bridge and Salmon River falls, or about Worthville, but records its occurrence near the head of the gulf about 2 miles west of Turin (1914, p. 293). In Canada he found it in different localities and at varying horizons in Quebec and Ontario east, possibly also in Ontario west, near Ottawa (1914,

p. 64[1]). Bassler (1915, p. 338) records the species as occurring in the Pulaski at Pulaski, Lorraine, etc., and in the Maysville at Cincinnati, Ohio. We have found the species at station 22*a* of the Lorraine section, above and below the railroad bridge at Pulaski, as well as in the outcrops of Whetstone gulf shale several miles below the village; at stations 7, 10 and 11 of the Whetstone gulf section, stations 13 and 14 of the Moose creek section and stations 8, 9 and 13 of the Wood creek section; everywhere as a rare fossil. From these occurrences it follows that the species, as here defined, is not restricted to the Pulaski beds, and is there absent in the upper horizons. In the Lorraine section we found it in zone V at the base of the Pulaski, at Pulaski in the Pulaski, as well as in zone IV of the Whetstone gulf shale, below the village; in the Whetstone gulf section in zones I and II; in the Moose creek section in zone V; in the Wood creek section in zones II and V. This would mean that the species occurs nearly throughout the lower Lorraine or Whetstone Gulf formation, corresponding to the Eden in age, and in the Pulaski formation, except the last zones. Specimens in our drift material show that it also occurs in the calcareous sandstone of the Pulaski.

We also have before us specimens in dark gray to black shale of the lower Whetstone Gulf formation near Rome (Rust collection).

Remarks. Cymatonota parallela Hall differs from C. recta Ulrich, which is also a Maysville form, essentially only in size, the western form attaining about the double size of the Pulaski species; the anterior also is distinctly narrower in the New York form. Finding the specimens in the dark shales of the lower Whetstone Gulf formation as a rule smaller than the typical material and also marked with stronger wrinkles along the cardinal line, we attempted to separate them from the Pulaski material, but found them, at the most, but varietally different.

The relative dimensions are the same, and the proportionally stronger cardinal wrinkles fade out posteriorly with advancing growth. The dorsal and ventral margins are, however, slightly divergent and the anterior portion a little broader and the anterior part of the hinge-line higher up; the variety in this feature approaching C. recta. It may, for this reason, be distinguished as mut. intermedia (see plate 5, figures 3–5).

The genus Cymatonota Ulrich (1893, p. 661) represented by this species in our fauna, bears peculiar characters which strongly suggest that C. parallela like its congener was a burrowing form. The shell is Solen-like, gaping more or less at both ends, with a long straight hinge-line, very thin and a thin edentulous hinge-plate. This burrowing habit may also explain, why, in spite of its obviously wide distribution and fairly long range, one finds the shells but rarely on the bedding planes with the rest of the fossils.

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[1] In his last publication (1924, p. 175) he cites these forms as approaching C. pholadis.

Genus Psiloconcha Ulrich

Psiloconcha subovalis Ulrich

Plate 6, figure 6

Psiloconcha subovalis Ulrich. Geol. Survey, Ohio, vol. 7, 1893, p. 666, pl. 52, figs. 5-7.

Psiloconcha subovalis Foerste. Bull. Sci. Lab. Denison Univ., 17, 1914, p. 295, pl. 2, fig. 15.

Psiloconcha subovalis Foerste. Mem. 138, Geol. Survey Canada, 1925, p. 195, pl. 25, fig. 7; pl. 30, fig. 15 *a*, *b*.

Foerste (1925, p. 95) has diagnosed this species as follows:

> Outline elliptical lengthwise, ventral margin curving evenly into anterior margin, latter rounding rapidly into hinge-line. Hinge-line straight. Length about twice height. Beaks very inconspicuous and located about one-sixth of the length of the shell from the anterior margin. Umbonal ridge fairly distinct though not at all conspicuous.

The species was originally described from the Bellevue member of the Maysville, Morrow, Ohio. Foerste records similar forms from the Waynesville, St Hilaire and from certain strata at Huron river. Miss Stewart figures it from the Don brickyard and as Foerste thinks also from the Humber vale quarry, Toronto, as P. suberecta. In New York the species has so far been noticed only in the drift material of the Pulaski formation (United States National Museum, *fide* Ulrich).

Psiloconcha sinuata Ulrich

Psiloconcha sinuata Ulrich. Geol. Surv. Ohio, 7, 1893, p. 668, pl. 52, figs. 15, 16.

Psiloconcha sinuata Foerste. Mem. 138, Geol. Surv. Canada, 1925, p. 196, pl. 25, fig. 6.

Foerste defines the species as follows:

> Outline elliptical; length almost 3 times the height. Mesial sinus sufficiently distinct to produce a slightly concave outline along almost the entire length of the ventral margin; umbonal ridge relatively distinct. Hinge-line about straight.

Psiloconcha sinuata occurs in the Maysville (Bellevue) at Cincinnati; and forms similar in outline are reported by Foerste from the Lorraine of the Proetus zone in the Nicolet river section, Quebec and at St Hilaire, Quebec. Our specimens were found associated with P. subovalis at station *22a* of the Lorraine gulf section (zone IV, or lowest Maysville).

Order **Anomalodesmacea**

Superfamily **Anatinacea**

Family **Pholadellidae** Miller (emend.)

Genus Rhytimya Ulrich

Rhytimya radiata Ulrich

Plate 6, figure 9

Rhytimya radiata Ulrich (1893, p. 693), an Eden (Southgate) species of Cincinnati and vicinity, has been found in our lower Lorraine at several stations, namely stations 1 and 3 of the Woodcreek section, station 7 of the Whetstone gulf section and station 5 of the Lorraine gulf section. Good specimens are also found in the Rust collection, on slabs of dark gray Lorraine shale from the neighborhood of Rome.

It is recognized by the following characters:

Shell below medium size, compressed-convex, elongate, the height being to the length as 3 to 8. Beaks small, little prominent, about one-fifth of the length of the shell from the anterior extremity; umbonal ridge very inconspicuous; mesial sulcus very slightly developed. Cardinal margin long, straight posterior to the beaks, declining anteriorly at an angle of about 20 degrees; anterior end contracted to two-thirds the height of the shell, angular above and uniformly rounded below; ventral margin straight in the middle; posterior margin slightly oblique above, strongly rounded below. Surface marked by crowded concentric growth-lines, which in front become bunched into about eight strong folds. Posterior half with radiating lines bearing distinct granules; the lines especially distinct upon the post-cardinal slope, where about twenty are counted.

Rhytimya compressa Ulrich

Plate 6, figures 7 and 8

An elaborate description is furnished by the author of the species (Ulrich, 1893, p. 692). Foerste has lately (1924, p. 198) given the following brief description:

Valves of very little convexity, preumbonal slopes flattened, without a mesial sulcus, ventral outline gently convex. Anterior part of hinge-line only slightly below the level of posterior portion. The posterior of the valve relatively tall. Granules exceedingly small, radiating lines formed by them just visible to the unassisted eye.

R. compressa, like R. producta is a Fairmount species of Cincinnati and vicinity. Foerste (1916, p. 245) has also observed forms very closely related to it in Quebec and Ontario east, and Miss Stewart (1920, p. 45) figures from the Don brickyard at Toronto a form closely resembling it in outline. In our sections it has been observed only at station *22a* of the Lorraine gulf section, where it is one of the more common fossils and occurs in large and beautifully preserved specimens, which often retain the fine radial lines of minute tubercles or spines on the entire surface save the anterior end; the tubercles increasing rapidly in size towards the basal margin, especially upon the umbonal region, where they are most distinct.

Rhytimya producta Ulrich

Plate 6, figures 10 and 11

Rhytimya compressa Ulrich. Geol. Surv. Ohio, 7, 1893, p. 688, pl. 56, figs. 6–9.

Rhytimya producta, according to Bassler, is a Maysville (Fairmount) form of Cincinnati and vicinity. We have before us a representative specimen in dark gray shale from station 14 of the Whetstone gulf section and a specimen in gray sandstone in the Museum collection, labeled " Lorraine Gorge." The beds at station 14 belong to zone V, which is the basal zone of the Maysville observed in the Lorraine gulf section.

The specimens here figured are readily recognized as representing this species by their elongate form, rounded posterior ends, sharp, regular, anterior folds, fairly prominent umbonal and anterior region and well-marked mesial sulcus. The radiating series of minute granules are not preserved.

Rhytimya plana nov.

Plate 6, figure 13

Description. Shell elongate, very flat, the outline narrowly subelliptical, highest in the anterior third, height (8.5 mm.) equaling about two-fifths of the length (21 mm). Cardinal and basal margins nearly straight and parallel in the middle of the shell; anterior end well rounded; posterior margin more narrowly rounded in the lower two-thirds, very oblique and nearly straight in the upper third. Beaks very small and very little prominent, situated less than one-fifth the length (4 mm) from the anterior end. Posterior as well as anterior umbonal ridges and sulcus so faint that they are barely noticeable. Concentric surface markings quite distinct under a lens, the posterior slope from the umbonal ridge marked by three or four faint radial linear depressions extending from the umbo.

Horizon and locality. Lower Pulaski shale, zone IV, station *22a* of Lorraine section.

Remarks. We had identified this flat, nearly smooth form in the first part (Bull. 258, p. 109) with Psiloconcha subovalis (Ulrich); a note by Doctor Ulrich suggesting that the form probably is a new Rhytimya and the observation of the radiating lines have led to the erection of this species. It approaches R. producta with which it is associated in the Lorraine section, in the slender form, but is flatter, more evenly rounded in front and the upper posterior margin is distinctly more oblique.

Rhytimya cancellata (Walcott)

This rare species was described by Walcott (1883, p. 22) as Modiolopsis cancellata from the upper Utica shale at Holland Patent, N. Y. It has been referred by Ulrich (1894, pp. 504, 628) to his genus Whiteavesia.

General form subelliptical convex; cardinal line nearly straight from the beak to the posterior margin; anterior end rounded from the cardinal line to the basal margin.

Basal line arcuate; posterior end obliquely truncate; umbonal ridge broadly rounded with a uniform convexity, to the basal margins.

Surface marked by strong concentric and radiating striae, which are strongly developed on the posterior half of the shell; the crossing of the striae gives a cancellated appearance which is not seen in the closely related Modiolopsis anodontoides. The broad umbonal ridge also distinguishes it from that species.

Bassler (1915, p. 1320) records the species as occurring also in the upper Trenton at West Covington, Kentucky; and Ulrich (1893, p. 657) has suggested that it may be based on merely a young example of one of the larger Whiteavesias as W. cincinnatiensis.

The type of this species has not been available to the writer but the United States National Museum contains specimens from the original locality, Holland Patent, identified by the author of the species as Modiolopsis cancellata. The best preserved of these plesiotypes comes from the Frankfort shale of that locality and is distinctly a Rhytimya, very closely related to R. radiata Ulrich. It has in common with that species the general outline and the presence of radiating lines of fine tubercles. It appears, however, at an earlier horizon (Utica-Frankfort transition beds and Frankfort beds), is smaller and possesses distinct radiating lines over the entire surface, which bear granules. The radiating lines are more closely arranged in radiata (about 3 in 1 mm), than in cancellata (2 in 1 mm).

The prominence of the radiating lines gave the species its name "cancellata," the enlarged figure of the surface sculpture by Walcott (*ibid*, figure 8*a*) shows, however, distinctly the tubercles, and his figure 8 brings out also the frontal folds, another feature characteristic of Rhytimya.

It seems that Rhytimya cancellata, radiata and compressa form a series of successive forms, increasing in size and decreasing in the development of the radial surface lines.

The plesiotype before us possesses the same length (17 mm) as Walcott's figure, but is somewhat higher (7 mm), although imperfect at the ventral margin.

Rhytimya obesa nov.

Description. Shell of medium size (28.5 mm long, slightly restored; 14 mm high); very convex (6.5 mm thick). Cardinal and basal margins subparallel, cardinal outline nearly straight, declining steeply in front of beak, ventral margin broadly sinuate in the middle; posterior margin (incomplete) probably well-rounded; anterior end short, fairly narrowly rounded. Beak prominent, full, incurved; situated less than one-fifth the length from the anterior extremity; umbonal ridge strongly convex, broad, evenly rounded. Mesial sulcus, broad, shallow but distinct. A small, but well-marked lunule in front of the beaks. Surface furnished with faint growth-lines and varices, the latter becoming prominent in front.

Horizon and locality. We have but one well-preserved example of this species. This comes from the drift near Trenton and is preserved in the typical rusty weathering calcareous sandstone of the upper Pulaski formation.

Remarks. This species seems to be well distinguished from all of its congeners by its ventricose shell. In outline it approaches R. byrnesi (Miller), a Richmond form, but is shorter and has a less developed median sulcus.

Rhytimya

Plate 6, figure 12

In part 1 (Bull. 258, p. 109) a specimen from station *22a* of the Lorraine gulf section has been cited as Modiolopsis anadontoides, that by Doctor Ulrich is considered a Rhytimya. It recalls R. byrnesi (Miller), a Richmond form, and may represent an undescribed species. It is, however, not sufficiently well preserved, its posterior margin lacking, for positive determination.

Superfamily **Trigoniacea**

Family **Lyrodesmidae** Ulrich

Genus **Lyrodesma** Conrad

Lyrodesma planum Conrad

Plate 7, figures 5 and 5*a*

Conrad in erecting the genus Lyrodesma in 1841 based it on a single species L. planum, of which he states that he had several specimens that came from the " Salmon River sandstone " of the vicinity of Rome. No further representatives of this species have apparently been found by later collectors, and Hall in volume 1 of Palaeontology of New York, restricts himself to copying Conrad's brief original description and his manuscript figure, stating that he has not himself seen the specimens. Conrad's types have been lost and search for other specimens in the neighborhood of Rome has so far been unsuccessful.

Conrad's description reads:

> Subrhomboidal, compressed; posterior margin widely and obtusely truncated; posterior basal margin rectilinear; extremity rounded.

A specimen found by us in sandy shale of the upper Pulaski beds in the Lorraine gulf section is probably referable to Conrad's lost species. It differs from the common L. poststriatum of this horizon in just those features which according to Conrad's description and figure would characterize his species. It is distinctly more elongate in outline than the associated congener, its length being 20 mm, its height 12 mm (in Conrad's figure respectively 22 and 13 mm); its anterior outline is fully rounded, passing roundly into that of the basal margin which is broadly convex but flattened toward the postero-basal angle, which is more angular and extended than in L. poststriatum. The beak is broader and less prominent than in the latter species and the valve much compressed, the highest part being about one-quarter the height from the beak. The cardinal slope is distinct and angular, but not as prominent as in L. poststriatum and slightly convex backward. It forms an angle of about 30 degrees with the longitudinal axis of the valve and is thus more slanting than in L. poststriatum. The cardinal slope is but partly preserved in our specimen. This is not smooth as in the type, but shows about three faint lines. The surface appears smooth, but is under the lens seen to be delicately sculptured by somewhat wavy concentric lines that are very sharp but so fine that 15 of them are counted in one millimeter.

This specimen was found in a small outcrop of sandstone and sandy shale in the bed of the creek, 35 feet below station 25 of the Lorraine section (zone VI) of Lyrodesma poststriatum and Ischyrodonta curta.

Lyrodesma conradi Ulrich

Plate 7, figures 1-4

This Eden (Southgate) species of the neighborhood of Cincinnati is represented by two specimens found in Wood creek in zone II of the lower Lorraine beds, corresponding to the Southgate zone of the Eden. These, while both imperfect, supplement each other in showing the characteristic features of the species as described by Ulrich, from whom we quote (1893 p. 684):

> Shell a little oblique, transversely subovate, somewhat the highest across the middle of the posterior end; length 15 to 22 mm; height 11.5 to 15 mm; thickness about half the height; just beneath the middle of the slightly oblique posterior margin the outline is a little produced and more narrowly rounded than elsewhere. Valves moderately convex, the posterior umbonal ridge rounded, not a prominent feature, the beaks small, situated just within the anterior third of the length. Surface marked by very fine, closely arranged, sharp concentric lines, crossed on the posterior cardinal slope by about ten radiating striae. Hinge with seven teeth of the usual type in each valve. Adductor scars distinct, the posterior one rather small and situated a very short distance beneath the submarginal pedal muscle impression. Pallial line with a small, although undeniable posterior sinus. A peculiar feature of the internal casts is the broad and shallow furrow shown in the figure just in front of the umbonal ridge.

The characters by which our specimens can be recognized as falling within the boundaries of L. conradi are the evenly convex surface, the rounded umbonal ridge, which contrasts in its lack of prominency with that of L. cincinnatiense and poststriatum, and the lesser produced postventral part of the posterior outline.

Lyrodesma poststriatum (Emmons) Hall

Plate 7, figures 6–10

This species was figured but not described by Emmons in the Second District Report, and referred by its author, as pointed out by Foerste, to the Utica shale, apparently because he had found this species associated with Triarthrus eatoni and used that trilobite as his guide fossil to draw the boundary between the Utica and Lorraine beds. Hall, in volume 1 of the Palaeontology of New York, fully described Lyrodesma poststriatum, stating that it occurs both " in the shaly and arenaceous part " of the Lorraine group, or in other words in the lower and upper Lorraine; and he also referred a Trenton form from Carlisle, Pa., to this species. The latter has later been described by Ulrich as L. cannonense,

In the study of the Lyrodesmas of the Lorraine group of New York it has now been found that several species can be distinguished. One of these is identical with L. conradi Ulrich, another with L. cincinnatiense Hall and the third and latest one agrees with Emmons' and Hall's figures and description of L. poststriatum. This latter has not been found by us in the lower Lorraine beds which carry Triarthrus eatoni and we have good reason to doubt that it occurs there and to believe that Emmons erred in placing it there. Since his type specimen has been lost and the species been emended by Hall, whose type came from the upper and Pulaski division and is available, it will be best to restrict the species to the Pulaski type and thus avoid confusion.

This upper Lorraine species of Lyrodesma for which the name "poststriatum" is preferable, is shown in Emmons' figure and in Hall's figure 10*b*, plate 82, *op. cit.* In the original of this figure the upper part of the anterior outline is more rotund than figured, according to Foerste.

The latter author has recently (1924, p. 169) furnished the following improved description:

> Shell longitudinally triangular ovate; anterior outline evenly rounded; that part of the ventral outline posterior to the beak gently convex; lower posterior outline more rapidly rounded than any other part of the margin, but with no tendency toward angulation, as in other species of Lyrodesma. Upper posterior outline gently convex and curving forward strongly, merging into posterior part of short hinge-line. Umbonal ridge relatively straight along the upper half

of its course, but along lower half curving progressively farther backward. Upper half of umbonal ridge strongly angulate, but its lower half with angulation less pronounced. Main body of the shell smooth or only faintly striated concentrically, concentric striae sharply defined only along the anterior border. Along the postumbonal slope the radiating striae are crossed by concentrically arranged striae readily visible to the eye. Five rather strong plications occupy the upper part of postumbonal slope, directly beneath the sharp marginal border along the top of the ridge. Lower part of the postumbonal slope occupied by three or four finer plications. In addition to these two sets of plications there is a tendency toward intercalation of still finer striae, especially between the larger plications.

To this we may add the following notes from our material.

Eight radially arranged and transversely striated cardinal teeth were observed in one specimen.

Adductor scars quite distinct in casts, the anterior one supported on the inside by a clavicle and stronger than the smaller posterior one. Pedal muscle impressions (see plate 7, figure 8) close to the hinge-line. Pallial line apparently simple or with a posterior sinus.

Formation and locality. L. poststriatum does not appear until zone VI of our Lorraine section, or in the third zone of the Pulaski formation. It ranges thence to the top of the formation where it was found by Doctor Foerste at the Salmon River falls. In zone VI of the Lorraine section it is a common and characteristic fossil and has therefore been named as a guide fossil of that zone. It is also one of the most common fossils in the uppermost beds exposed at Pulaski.

Lyrodesma cincinnatiense Hall

Plate 7, figures 11–16

Lyrodesma cincinnatiense was described by Hall (1872, p. 227 and 1875, p. 82) from the inner side of the valves only.

The Pulaski beds of New York in the Lorraine section have afforded specimens that according to Doctor Ulrich in outline and hinge are identical with the Cincinnati form. From these we have derived the following description:

Description. Shell transversely subovate, length to width as 2:3; small, the average dimensions being length 10–11 mm; height 7–7.5 mm; flat or much compressed convex; a mature specimen about 1 mm thick; thickest near the beak and sloping fairly evenly to the basal margin. Anterior margin strongly rounded, projecting most in the upper part; basal margin well rounded in some and but slightly convex in other specimens; posterior margin very oblique, forming a sharp angle with the basal margin. Hinge-line short. Beaks small and very little prominent, situated more than one-third of the length from the anterior extremity of the valve; umbonal ridge prominent, sharp, sigmoidal, forming an angle of 40 degrees with the base. Cardinal slope not quite one-quarter of surface of valve, steeply declining, slightly convex, furnished with four to ten striae which vary greatly in size and frequently alternate with faint intercalated lines. The remainder of the surface of the valve is smooth or shows only very faint growth-lines. A hinge-plate, possibly not quite perfect at the anterior end bears six (originally possibly seven) hinge teeth radiatingly arranged and transversely crenulated.

The muscle-scars have not been observed.

Formation and locality. Lyrodesma cincinnatiense is a fairly common form in zone V of the Lorraine section, which is the second zone of the Pulaski formation. It has also been recorded and figured by Miss Stewart (1920, p. 27) from the Humber river region near Toronto. The Canadian form is relatively higher and shorter in outline than ours.

Remarks. This species differs from the more widely distributed L. poststriatum in its smaller size. being just half the size of the later form, the more central position of the beaks and the flatter valves and the umbonal ridge. In general outline it resembles that species more than any other congener.

Class **Gastropoda**

Order **Aspidobranchia**

Family **Acmaeidae** Dall

Genus **Archinacella** Ulrich and Scofield

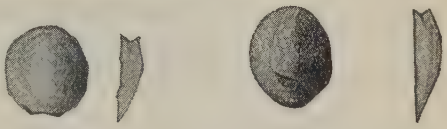
Archinacella subcarinata nov.

Plate 8, figures 1 and 2

The Archinacella of the Pulaski formation has been distinguished by Foerste from the Trenton form A. patelliformis with which it had been identified by Hall. That of the Whetstone Gulf formation, or lower Lorraine proves to be nearer to A. patelliformis, but also different.

The shell is smaller than that of A. pulaskiensis and about the size of that of A. patelliformis, its average size being 9 mm. The largest specimen observed is 12 mm long, 7.3 mm wide and 2.7 mm high. The form is thus much more elongate than in pulaskiensis and still slightly more so than in patelliformis. It is, moreover, more rapidly contracted toward both the anterior and posterior ends, giving the outline a somewhat biconvex, lenticular shape. In profile view the shell is very similar to that of patelliformis, but the beak which is quite pointed, projects beyond the anterior margin; the anterior line between the apex and margin is moderately concave, the dorsal line rather evenly convex, culminating anteriorly of the center. The tendency to carination is more strongly developed than in pulaskiensis and carried to the posterior margin. The surface is smooth, or showing only faint growth-lines, even in the shale, which as a rule beautifully preserves the finest details of surface sculpture.

From A. pulaskiensis this species differs in the more elongate outline, more advanced beak, and carinate dorsum; from A. patelliformis in the subacute anterior and posterior outlines and the smooth surface. The nearest relative of our species appears to be A. simulatrix. U. & S., a western type of Black River age. It has a similar sharply rounded high back and wider anterior half, but is broader in outline.


15 16

Figures 15 and 16 Archinacella pulaskiensis Foerste. Natural size, from Pulaski, N. Y. Foerste's figures.

Horizon and locality. We have collected this species at stations 4 and 22*a* of the Lorraine gulf section, stations 10 and 12 of the Mill creek section, 11–12 of the Moose creek section and stations 2, 6, 9 and 10 of the Wood creek section. It therefore ranges throughout the Whetstone Gulf formation and would also seem to enter the lowest Pulaski shales, thus overlapping in its range to some extent with A. pulaskiensis.

Archinacella pulaskiensis Foerste

Carinaropsis patelliformis Hall. Pal. N. Y., v. 1, 1847, pl. 83, figs. 7*a*, 7*b*.

Doctor Foerste (1914, p. 309) describes this species as follows:

> The form, figured by Hall from the Lorraine at Pulaski, N. Y., as Archinacella (Carinaropsis) patelliformis, differs in outline from his Trenton types, which were derived from the dark, compact, Trenton limestone at Middleville, N. Y. This shell is broader and more convex along the middle and the outline, therefore, is rather broadly ovate than ovate oblong. Otherwise,

the two shells are closely similar. The beak extends almost or fully as far forward as the anterior margin of the shell. It overhangs this margin by an anterior slope which on lateral view is not so strongly concave. The beak is rather pointed, especially when viewed from above and there is a tendency toward carination for a moderate distance posterior to the beak. The highest part of the shell is about five-twelfths of the length of the shell from the anterior margin. The shell is smooth, surface striations being faint or absent.

Doctor Foerste found specimens in the Pulaski beds at Pulaski below the railroad bridge; within the limits of Lorraine village, at Barnes Corners and Bennett bridge. The writer has also observed this species at stations 17, 24–27 of the Lorraine section. It would thus seem to range through all of the Pulaski formation and go even below it. Its geographic distribution extends to Quebec, where it occurs on the Richelieu river, at Chambly (Foerste, 1914, p. 310), and to Toronto, Ontario (Parks & Fritz, 1923, p. 2).

Family **Cyrtolitidae** Ulrich and Scofield

Genus **Cyrtolites** Conrad

Cyrtolites ornatus (Conrad)

Plate 8, figures 3 and 4

Cyrtolites ornatus is the most characteristic gastropod of the Pulaski formation, to which it is restricted, in this State, and throughout which it ranges. It was first very briefly described but not figured by Conrad in the Annual Geological Report for 1838 and in the Palaeontology of New York, volume 1 (p. 308, plate 84, figure 1), was fully described and figured by Hall. A still more elaborate description has been furnished by Ulrich and Scofield (1897, p. 860):

Cyrtolites ornatus ranges in the Ohio basin through the Maysville and Richmond groups and is found from Quebec to Alabama in the south and to Indiana in the west. In New York it was known to Hall from the " central and higher part of the Hudson River group, at Turin, Boonville, Rome, Pulaski, Washingtonville, Lorraine, Rodman and other localities." Foerste (1916, p. 6, 7) has recorded its occurrence in the outcrops from Lorraine village to the east of Worthville, and in the highest Lorraine beds at Bennett bridge and Salmon River falls. We have observed it at stations 17, 22*a*, 25–27 of the Lorraine gulf section, stations 12 and 14 of the Whetstone gulf section; 10, 12 and 15 of the Mill creek section; 6, 9, 13 and 14 of the Wood creek section. This means, that in New York it appears already in beds of the Whetstone Gulf (Eden) formation, corresponding to the Southgate member, namely, station 17 of Lorraine section, station 12 of Whetstone Gulf section, 12 and 15 of the Mill creek section and 6 and 9 of the Wood creek section. In the Mill creek section at station 10 it even appears still a little earlier in very characteristic specimens.

We also have before us specimens with finely preserved reticulate surface in black Whetstone Gulf shale with Triarthrus eatoni from the neighborhood of Rome (Rust purchase, collected by C. Valient).

Considering that a smaller mutation of C. ornatus, namely, C. ornatus minor Ulrich and Scofield, appears already in the Trenton of Minnesota and New Jersey; and the species in the Lorraine is really a survival of earlier times, it is hardly to be wondered that it should be found at earlier levels in different regions.

Family **Sinuitidae** Dall and Bassler

Genus **Sinuites** Koken

Sinuites planodorsatus (Ulrich)

Plate 8, figure 5

S. planodorsatus is briefly characterized by Ulrich (1897, p. 871) as follows:

> Of this species we have six specimens. These show that it is of the type of P. granistriata — perhaps it should be called a variety of that species — differing in having the flattening of the back of the last volution much more decided, while the central ridge is wanting entirely, at any rate it is so for the outer volution. The dorsum of the volutions seems to be rather narrowly rounded. The surface markings are essentially the same in the two forms, as is also the form of the aperture and the dimensions, the largest specimen being about 24 mm in height.
>
> The broad dorsal flattening will distinguish P. planodorsatus at once from all other species of the genus and family known.

The species has so far been known only from the Eden (Southgate) of Covington, Kentucky. Doctor Ulrich while looking over my material recognized it in specimens from station 1 of the Wood creek section. It there occurs also at station 9, where it fills a thin band, and it has further been observed at station 9 of the Moose creek section. It thus appears here already in beds of Economy age and continues through the Southgate age. Two characteristic specimens were also seen in the United States National Museum from the lower Lorraine shale, 1½ miles east of Rome, N. Y.

There is no doubt that also scattered individuals of Sinuites in the Pulaski formation exhibit a distinctly flattened dorsum (see plate 8 figure 6) while otherwise referable to S. cancellatus.

Sinuites cancellatus (Hall)

Plate 8, figure 6

This common Lorraine fossil is generally known as Bellerophon bilobatus Sowerby, because Emmons (1842, p. 392), who first figured it, identified it with Sowerby's species and was strongly corroborated in this by Hall (1847, p. 184). Ulrich and Scofield (1897, p. 872), however, came to the conviction that the common bellerophontid of our Trenton and Lorraine groups, that had passed under the name "bilobatus," is specifically different and since Hall had distinguished the Lorraine occurrence of the form with preserved cancellated sculpture as Bellerophon cancellatus (1847, p. 307), this name acquired priority.

Koken (1896, p. 392) as well as Ulrich and Scofield (1897, p. 867) recognized the fact at about the same time, that the genus Bellerophon Montfort, as restricted by Waagen, could not any more include forms like cancellatus, that lack the slit-band and have a wide sinus in the outer lip, Koken proposing for them the name of " Sinuites," Ulrich and Scofield that of " Protowarthia ". Although the latter name was at once adopted by American palaeontologists, it had to yield to the slight priority of the other term Sinuites, brought forward by Dall in Zittel-Eastman's Textbook, 2 ed. 1913. Thus the well-known "Bellerophon bilobatus" of the collectors has, by stages, been transformed into Sinuites cancellatus.

Sinuites cancellatus has been described by Hall (1847, p. 184, 307) and fully discussed in the various aspects owing to its great range, by Ulrich and Scofield (1897, p. 872). By these authors and our material it is brought out that S. cancellatus is of medium to large size, reaching its largest size in the Lorraine formation. Its general form is subglobose, owing to its rather close coiling and the well-rounded back of the volutions. Its aperture is transverse, about twice as wide as high, its width equalling the height of the entire shell. The apertural lobes possess a rounded outline and the sinus in the outer lip is broadly rounded. Shell composed of several layers, the outermost of which, rarely preserved, carries a beautiful pattern of fine transverse and revolving lines, so fine that they are barely visible to the naked eye; six of the revolving lines being counted within 1 mm in the Lorraine material.

This pattern is near the umbilicus replaced by one of irregular or wavy revolving lines. Usually only the inner layer is preserved and the shell smooth.

The specimen here reproduced in pl. 8 fig. 6, of unusual size, also found in the Lorraine material, is more than twice the size of the average Trenton representatives.

S. cancellatus is very common in the impure limestone beds of the Pulaski formation, where it is always smooth. Its cancellated surface is frequently well preserved in shales of that formation where, however, the shape is lost through compression. In the Whetstone Gulf shales the species is present but rare and the genus more frequently represented by the next species, S. granistriatus and S. planodorsatus.

Sinuites granistriatus (Ulrich)

Plate 8, figures 7 and 8

For *original description* see Ulrich (1897, p. 870).

This species is said by Ulrich to be near S. cancellatus " but that species has a slightly deeper sinus, and a rounder back, the back never being flattened, nor is there ever a sign of the low dorsal ridge and obscure furrows characterizing P. granistriata.''

Horizon and locality. Thus far this species has been known only from the Eden (Southgate) of Cincinnati, Ohio, and vicinity. We have observed specimens of S. granistriatus at station 17 of the Lorraine gulf section and station 8 of the Wood creek section and station 9 of the Whetstone gulf section. The first two of these localities are in our zone II (Southgate member) and the last may be a little older and of Economy age. A number of specimens, beautifully preserving the sculpture, were also found, in a collection of fossils from the dark shales of the lower Whetstone Gulf formation " near Rome " in the Rust collection, now in the State Museum and in the United States National Museum (" 1½ miles east of Rome ").

Family **Bucaniidae** Ulrich

Genus **Tetranota** Ulrich and Scofield

Tetranota rugosa (Emmons)

Plate 8, figure 9

Emmons (1855, p. 166) has described this species as follows:

Volutions about three, larger angulated and the larger part covered with striae, sharply arched upon the wide, dorsal, grooved band at the curve, both the striae and band are discontinued and replaced by rather distant waving lines; aperture undetermined (Rare). Loraine shales and sandstone, Loraine, Jefferson county, N. Y.

We have obtained but a single specimen, of this obviously rare species, at Station 17 of the Lorraine gulf section; or in beds corresponding to our zone II of the Whetstone Gulf formation, an to the Southgate member of the Eden. It can not be established any more from which horizon Emmons' type came and whether he may not have found it in the upper or Pulaski division.

Our specimen is considerably smaller than the holotype if the latter is drawn in natural size; but agrees with it in general outline, as far as the latter can be made out in the considerably flattened and imperfect specimen, as especially in the large relative width and depression of the slit-band, the sharpness of the striae and the depressed zones on either side of the slit-band. By the depressed and broad slit-band and the paralleling depressions on both sides of it, B. rugosus is readily distinguished from two congeners that might occur in our Lorraine, namely, B. cincinnatiensis Miller and Faber (1894, p. 29), a Maysville form of Cincinnati, and B. recurvus Ulrich (1897, p. 920), a Maysville (Corryville) species of the same region. Both are keeled on the dorsal side.

The slit-band in our specimen is slightly concave and nearly smooth; in oblique light, however, showing indistinct lunulae. Its margins are sharply defined, although hardly raised, as in bilineatus and other species. The growth-lines are very sharp, filiform, and evenly spaced. The whorls were rather broad, inflated, though distinctly depressed on both sides of the slit-band. The aperture was but little expanded laterally; and as shown by the strong posterior curve of the growth-lines on the dorsum, provided with a deep central emagination leading into the slit-band. The lower lip and the umbilicus have not been observed.

Family **Pleurotomariidae** d' Orbigny

Genus **Lophospira** Whitfield

Lophospira bowdeni (Safford)

Plate 8, figure 10

This, the Murchisonia bowdeni of Safford (Geology of Tennessee, 1869, plate 3 (*G*), figures *2a–2c*), is a long range form that lived from Trenton to Richmond time and occurs from Tennessee to Quebec and Ontario (Foerste, 1916, p. 253). In New

York it has been observed only in the highest horizons of the Lorraine gulf section (stations 25 and 27*a*, at the former of which it is very common), at Pulaski and in the brown drift blocks derived from the upper Pulaski beds.

The species has been elaborately described in all the variations incidental to its wide range, by Ulrich and Scofield (1897, p. 986).

Foerste, who has separated the forms with larger apical angle, occurring in the Waynesville, as L. beatrice gives the following brief description of the restricted species L. bowdeni:

> Apical angle averaging about 27 degrees; volutions eight to ten; peripheral angle only moderately prominent. Upper slope of whorls obscurely carinated near the suture, but more or less concave between this carination and the peripheral band. Along the lower side of the body whorl is another carination, usually obscure and never sharp. Umbilicus minute, usually more or less covered by the reflexed inner lip of the aperture. Surface striae curving backward into a strong V-shaped notch at the peripheral band.

Lophospira cf. **bicincta** (Hall)

The presence of Lophospira bicincta (Hall), the Murchisonia bicincta Hall of the Trenton limestone, in the Lorraine beds is at least suggested, although not proved, by the occurrence of internal casts showing a carina both above and below the raised slit-band. Since this species in the West ranges from the Stones River to the Richmond, its presence in our Lorraine would be neither strange, nor of any great importance, the species, on account of its long range being of little stratigraphic importance.

Lophospira abbreviata (Hall)

Plate 8, figures 11–13

The small gastropod designated by this name was originally briefly described by Hall as Murchisonia uniangulata var. abbreviata (1847, p. 304). Foerste (1914, p. 311) has more fully described it from the originals, deposited in the American Museum of Natural History.

> The species . . . belongs to the Robusta section of the genus Lophospira, as divided by Ulrich in his Monograph of the Lower Silurian Gastropoda of Minnesota. The type of Lophospira abbreviata was found at Pulaski, in rock containing Calymene, Orthoceras with transverse striae as in Orthoceras lamellosum, Cyrtolites ornatus, Hormotoma gracilis, Byssonychia radiata, and the common Lorraine

form of Dalmanella. Apical angle between 60 and 65 degrees. The transverse striae form a strongly reentrant angle toward the peripheral band. This band is tricarinate, or trilineate; in typical specimens, the middle line is scarcely more prominent than the other two; the intermediate spaces are concave. The slope of the whorl above the peripheral band is gently convex excepting in the immediate vicinity of the band where it is gently concave. That part of the whorl which is below the peripheral band is evenly and somewhat more strongly convex. In one specimen there is a trace of a revolving angulation very much farther down than in Lophospira lirata, Ulrich. " Shells of this type, with subrotund whorls and trilineate peripheral bands, the three lines nearly subequal, appear sufficiently distinct from the typical forms of Lophospira to receive a distinct designation," for which the term " Ruedemannia " was selected by Doctor Foerste.[1]

Hall records the species as occurring " in the calcareous higher portions of the group at Turin, Lewis county, and in a similar situation near Rome, Oneida county." (Namely, in the Pulaski formation.) Whitfield and Hovey (1898, p. 52-53), give, however, Pulaski as the locality of the type specimen, plate 83, figure 2*a*, and are corroborated in this by Foerste, who further states that the type of Hall's figure 2*b* (not recorded by Whitfield and Hovey) is on the same slab with the type of Ormoceras crebriseptum (plate 87, figure 2*b* *op. cit.*) which is also recorded in the catalog of the fossils of the American Museum as coming from Pulaski, N. Y. The original of figure 2*d* comes from the Mohawk valley and probably does not belong here.

This species is one of the rare Lorraine fossils. Foerste (1916) does not record having observed it either in New York or Canada and the writer has found it only at three places, namely, station 21 of the Lorraine gulf section, and station 12 of the Whetstone gulf and Mill creek sections. It would thus seem to appear already in the Whetstone Gulf formation (zones II and III) and reach its principal development in the lower Pulaski formation.

The ferruginous drift blocks of the Pulaski limestone sometimes contain the internal casts of this species in great profusion, thereby demonstrating its abundance at certain as yet undetermined horizons of the Pulaski formation. These specimens while attaining twice the size of Hall's types, agree with them in the apical angle, number (four) and character of volutions. Traces of the tricarinate band are noticeable in squeezes of the external moulds.

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[1] Regarding this new term Dr. Foerste states in his last publication (1924, p. 211): " The term Ruedemannia " was intended to cover those species of Lophospira which were included by Ulrich in his L. robusta group, but the species L. lirata Ulrich was chosen as the type. This is a species having a distinctly trilineate peripheral band, as in a typical Lophospira, but the whorls are rotund rather than angular and the lower surface of the body whorl is striated parallel to the band.

Lophospira lirata Ulrich

Two imperfect specimens (last whorls) from the lower Whetstone Gulf shale, 1½ miles east of Rome, N. Y., now in the United States National Museum (no. 23570) exhibit the essential characters of L. lirata Ulrich, namely, a convex slightly prominent, median, trilineate band, flanked on the upper and lower slopes by rather weak carinae. Below the lower carina faint traces of a number of revolving ribs can be noticed. The upper slope is flat or gently concave between the carinae, the lower gently concave between the median band and the carina, and convex below. The growth-lines are delicate, and hardly noticeable, more as in L. tenuistriata Ulrich, while the typical lirata has sharp, threadlike transverse lines. The obscuration of the originally sharp growth-lines is, however, explained by the complete solution of the shell and the resulting combination of the outer and inner surfaces and flattening of surface sculpture in much of the shale material.

Lophospira lirata Ulrich has before been observed only in the lower Eden (Economy and Southgate) of Cincinnati and vicinity. From Plethospira quadricarinata nov. which occurs in the same horizon, it is readily distinguished by the convex trilineate band.

Genus **Hormotoma** Salter

Hormotoma gracilis (Hall) var. **sublaxa** Ulrich and Scofield

Plate 8, figure 14

This common form of the Lorraine beds of New York is the Murchisonia gracilis of Hall (Palaeontology of New York, volume 1). The type-material of the species is derived from the Trenton limestone, but the extension of the species into Lorraine time is there recorded (*ibid.* p. 308), Hall stating: "This species is abundant in the shales and calcareous portions of the sandstones of this group, but I have never been able to obtain one where the shell is preserved." It is further said by the same author that it occurs throughout the group, and is one of the most common forms at Turin, Lorraine, Washingtonville, Pulaski and Rome. We have found it to be rather rare in the Whetstone Gulf formation, but becoming common in the Pulaski beds. In the Lorraine gulf section, it occurs at stations 17, 21*a*, 22*a*, 24–27. It is thus again absent in the upper Pulaski horizons of the Lorraine section, an observation in accordance with its absence in the highest Lorraine beds exposed at Bennett bridge and Salmon River falls, recorded by Foerste (1916, p. 7). It reappears, however, in the Richmond beds (see Bassler 1915, p. 645).

Foerste has referred the occurrences of Hormotoma gracilis in the Lorraine beds to the var. sublaxa Ulrich and Scofield (1897, p. 1015). This latter, recognized by its authors from material of the Black River (Auburn — Decorah) limestone of Missouri, is distinguished from the typical gracilis "by its rather loosely coiled volutions, deep oblique suture, and wide band."

The Lorraine material obtained by us is equally deficient with that figured by Hall in exhibiting the surface sculpture. We therefore refer here to Ulrich and Scofield's figures, taken from the better preserved Black River material, for illustrations of this common Lorraine form. These authors have also furnished a full description of the species and its varieties (1897, p. 1014 ff.).

Hormotoma salteri Ulrich

A specimen from the lower Pulaski shale of the Lorraine section, where it is associated on the same slab with Glyptorthis crispata, is at once distinguished from H. gracilis sublaxa, by its greater size (33mm long, corresponding to a complete specimen of 37 mm length, and 12.3 mm wide at the last volution) and its greater apical angle (23 degrees). It agrees in these features with H. salteri, a species hitherto only cited from the Trenton group. Ulrich describes this species, the Murchisonia (Hormotoma) gracilis Salter, (non Hall) (1859, p. 22) as follows:

> Height 25 to 40 mm; apical angle 20 degrees to 24 degrees in typical form; volutions nine or ten, rounded, more or less distinctly thickened above at the suture and flat or concave just beneath; band rather wide, flat or slightly concave, a trifle beneath the center in the typical form; lines of growth unequal, rather fine, never sharp.

He adds that it is a larger shell and has a wider apical angle than H. gracilis; and that in the typical form the thickening of the upper edge is usually a well-marked feature. This thickening is also plainly visible in our specimen and represented in the figure.

Genus **Liospira** Ulrich and Scofield

Liospira micula (Hall)

Plate 8, figures 15–18

This common species of the New York Lorraine was first figured but not described by Hall (1862, p. 55, figure 1). It has since been described by Ulrich and Scofield (1897, p. 995) and Weller (1903, p. 183) and is known to range from the Trenton formation into the Richmond, and to occur from Wisconsin to New Jersey and Quebec (*fide* Foerste).

In the Lorraine beds of New York it is found in the shaly layers; is therefore always more or less compressed and little favorable to the elucidation of its characters, which according to Ulrich, Scofield and Weller are as follows:

> Shell small, discoidal-lenticular, consisting of about four volutions. The umbilicus filled by a perfectly smooth, rather distinctly outlined concave, reflexed callosity of the inner lip. The sutures very shallow; the spire forming an almost continuous, even slope from the apex to the periphery, the apical angle being from 120 degrees to 127 degrees. The periphery of the outer volution is sharply angular in the casts, but is more rounded when the shell is preserved. The volutions subrhomboidal in section. The aperture irregularly triangular in outline, wider than high, the inner lip nearly vertical. The surface markings usually consist of fine lines of growth only, but nearly all of the best specimens show traces of an exceedingly fine set of revolving lines. On the under surface of the whorls the lines of growth make a broad curve, the inner half being the most curved. The band, which occupies the periphery, is distinguishable only on the best specimens.

The average size of L. micula is given as 9–12 mm, in some of our Lorraine horizons the specimens reach little beyond 5 mm while in others they attain their full size. Those here figured are from a locality just above the railroad bridge at Pulaski. The species has also been collected in the Lorraine gulf section (stations 4, 6, 7, 8, 9–10, 11, 12–13, 14, 22*a*, especially common at 9–10) in the Whetstone gulf (stations 5, 6, 9, 14); Mill creek (station 9), Moose creek (stations 8, 9, 11–12) and Wood creek (2, 4, 6, 8, 9, 10). It is much more common in the shales of the lower Lorraine (Whetstone Gulf formation) than in those of the lower upper Lorraine (lower Pulaski) and has not been observed in the upper Pulaski horizons.

To give a better conception of the appearance of this common Lorraine form than our crushed specimens afford, we have also copied Ulrich's excellent drawings of a specimen from the Fulton of Covington, Kentucky.

The specimens from the Utica shale of the Mohawk valley and the lower shales of the Lorraine group at Turin and Pulaski, figured by Hall in Palaeontology of New York, volume 1, plate 83, figures 5a, 5b as "Pleurotomaria (species undetermined)," probably belong also to this species. One of these (type of figure 5*b*) is preserved in the American Museum of Natural History in an embedded cast.

Liospira vitruvia (Billings)

Plate 8, figure 19

Liospira vitruvia, first described by Billings (1865, p. 171) as Pleurotomaria vitruvia, but not figured, from the Black River limestone of Pauquette's rapids on the Ottawa river, is not rare in the Whetstone Gulf shale in the neighborhood of Rome, but always completely flattened out and therefore only recognizable by its outline and size.

The species is now known to range from the Black River group into the Richmond and to extend from Wisconsin to Quebec. It has been redescribed and excellently figured by Ulrich and Scofield (1897, p. 995).

The principal peculiarities of the species, which reaches, in the average, a size of 25 mm, occur on the underside; they consist notably of the open umbilicus with its angular margin and flattened sides, and the unusual prominence of the central portion of the outline of the lower lip.

Genus Seelya Ulrich

Seelya sp. nov.

Plate 9, figure 1

The presence of a representative of the genus Seelya Ulrich in the Whetstone Gulf formation is indicated by the whorl figured on plate 9, figure 1. This exhibits one revolving carina above the slit-band and four below, the uppermost of which is indistinct. The slit-band is broad, concave and distinctly margined by two sharp carinae. The upper surface of the volution is concave between the suture and carina and again between the latter and the slit-band; the underside is convex and the whole volution well-rounded, except the area between the slit-band and the first carina, which is also concave. The growth lines are not distinctly shown.

The form of the volution and the sculpture are very closely alike to that of L. mundula Ulrich, with the exception that our form has two more carinae on the lower side.

The specimen is from the Rust collection (Valient collector) and the neighborhood of Rome.

Genus **Plethospira** Ulrich

Plethospira quadricarinata nov.

Plate 9, figures 2–5

Description. Shell below medium size, height about 20 mm, width 17 mm; in form subconical; apical angle 60 degrees or more; volutions four, well-rounded in general outline with two carinae, distinctly concave above between the suture and the upper carina, and the latter and the band; also concave between the band and the lower carina, convex below the lower carina; band supramedian, fairly broad, distinctly concave, with sharply raised margins; growth-lines regular, very distinct filiform, four in 1 mm; curving strongly backward above, forward between the band and the lower carina, and approximately vertical below the latter; lunulae obscure. Aperture rounded, pentagonal in section, outer and columellar lip not observed. Umbilicus small.

Horizon and locality. Common at stations 1 and 9 of the Wood creek section, and also occurring at stations 8 and 10 of the Wood creek section and station 12 of the Mill creek section, and thus represented in both the first and second divisions of the Whetstone Gulf formation, which correspond to the Economy and Southgate members of the Eden. While at station 1 it is common throughout the black shale, it was found at station 9 restricted to a thin limestone band which it completely fills.

The United States National Museum contains specimens from the lowest Whetstone Gulf formation, 1½ miles east of Rome (Rust collection, no. 34616).

Remarks. Of the two congeners in the Cincinnatian group, P. semele (Hall) and striata Ulrich, our form is more similar to semele, at least in outline, but readily distinguished by the four carinae on the volutions, which are to be regarded as its diagnostic character, for owing to the preservation in shale and in thin, impure limestone bands all specimens are badly flattened, though their sculpture is beautifully preserved, and the general outline as well as the form of the aperture have to be made out by conjecture. Upon the last volution of mature individuals the lower carina, and sometimes also the upper carina, become obscure.

Genus **Eotomaria** Ulrich

Eotomaria sp. cf. **canalifera** (Ulrich)

An Eotomaria recalling in size and direction of growth-lines the E. canalifera Ulrich, but apparently new, occurs at station 1 of the Wood creek section. It is, however, too much compressed and too imperfectly preserved to warrant description. Its growth-lines are sharp, filiform, densely crowded and irregularly arranged into bundles in some places, but oftener fairly equally spaced. They curve slightly forward upon the upper side until near the band, where they turn backward; on the underside they describe a shallow double curve, first curving forward then backward and finally forward again. The band is slightly concave, nearly flat, the growth-line distinct upon it and bent gently backward.

It is possible that some of the specimens, cited in the lists as Liospira vitruvia, may also be exfoliated and flattened specimens of this species.

Eotomaria pagoda nov.

Plate 9, figures 6–8

The Pulaski calcareous sandstone boulders of the drift of central New York have afforded a gastropod of peculiar outline and representative of an undescribed species. In part 1 (Bulletin 258, p. 122) we have cited the form as Lophospira tropidophora (Meek), with which our material has some similarity. The outline is, however, broader and the band, which is peripheral, is seen at the right side of the figured specimen to be distinctly concave. The specimens appear therefore to represent, as Doctor Ulrich has suggested, a species of Eotomaria. Although the shells are only casts of the interior, they are so characteristic in outline that we venture to describe the species from them.

Description. Shell large for the genus, rather high, distinctly turriculate, moderately convex below, with a very small umbilicus and distinct sutures. Band concave, sharply defined, slightly oblique to nearly vertical in position, at the periphery of the whorl. Upper and lower borders probably equally prominent. The contour of the upper surface either gently concave or somewhat sigmoidal, the lower portion being concave, the upper convex, in the cast at least. Aperture not fully seen, but probably subrhomboidal. Surface sculpture not seen.

Width of type 26.5 mm; height (reconstructed) about 30 mm.

A paratype with a width of 23 mm shows a height of 25 mm and was originally about 29 mm long.

Formation and locality. Pulaski sandstone drift near Trenton and Lorraine.

Remarks. This species is readily distinguished from its congeners by its relatively greater height, larger size and sharply turreted contour.

Genus **Clathrospira** Ulrich and Scofield

Clathrospira subconica (Hall)

Clathrospira subconica was first described by Hall in Palaeontology of New York, volume 1, as Pleurotomaria subconica from the Trenton limestone, and its occurrence, though in poorly preserved specimens, in the Lorraine beds at Turin and Pulaski, was noted (*ibid*, p. 304) and figures of Lorraine specimens given (*ibid*, plate 83, figures 3*a*–3*e*).

Ulrich furnished later (1897, p. 1006) a more elaborate description and record of its range and geographic distribution in the Middle West. It ranges from the Black River to the Richmond formation and is found from Minnesota and Tennessee in the West and South to Anticosti and Quebec in the northeast (Bassler, 1915, p. 225; Foerste, 1916, p. 248, 1925, p. 210).

In the Lorraine group we have found this species present in the calcareous sandstones of the Pulaski formation, whence it has passed into the drift material, the main source of the Lorraine collection. It is there only seen in casts. A few specimens, referable to this species, have also been seen in zone II of the Whetstone Gulf formation (Wood creek section, station 9).

Clathrospira conica Ulrich and Scofield

Plate 9, figures 9–11

This species has often been confused with the young of C. subconica. It was first recognized by Ulrich and Scofield (1897, p. 1008) as an independent form. It is, according to these authorities, distinguished from C. subconica by its smaller size, its width averaging 18 mm, and reaching a maximum of 25 mm, and differs constantly in at least two particulars, " First, the upper slope of the whorls is nowhere convex but is either gently concave throughout or flat from the linear suture to the rising base of the upper boundary of the peripheral band. The second difference lies in a more or less well-marked concave space which occupies the outer third of the base of the whorls."

Bassler (1915, p. 229) records C. conica from the Black River and Trenton of Minnesota, Kentucky and Baffin Land and the Maysville of Cincinnati and vicinity. In New York it is found in the Pulaski, corresponding in age to the Maysville, at Pulaski and in the Lorraine section (station *22a*).

Family **Euomphalidae** de Koninck

Genus **Eccyliomphalus** Portlock

Eccyliomphalus trentonensis (Conrad) mut. **fimbriatus** nov.

Plate 9, figure 12

In part 1 (Bulletin 258, p. 91) a gastropod from station 1 of the Wood creek section has been cited as Eccyliomphalus sp. that is a new form and deserves recognition. Its characters are the following:

Shell small, consisting of but one volution or less, coiled in one plane expanding rapidly (to double diameter in a quarter volution). Cross section angularly subovate. The inner side of the volution is convex, the sides steeply rising to the lateral angulation. Outer side with peripheral keel-like angulation, the two slopes of the outer side flat. Apertural margin slightly advanced on upper side.

Surface of the shell marked by sharp, undulating or fimbriate lines, numbering 18–19 in 10 mm near the aperture. The lines are overlapping forward and appear to have been continued into short collarlike extensions.

Length of shell on a straight line from initial point to aperture 11.5 mm, width at aperture 5 mm.

Horizon and locality. Whetstone Gulf shale, zone I of Cryptolithus bellulus and Bollia pulchra.

Remarks. This form is closely related to the Trenton species E. trentonensis Hall in outline, and sculpture. It posesses, however, a distinctly faster rate of expansion and more distinctly fimbriate sculpture-lines.

Family **Trochonematidae** Zittel

Genus **Trochonema** Salter

Trochonema (Eunema) nitidum (Ulrich)

Plate 9, figures 13 and 14

Trochonema (Eunema) nitidum is described by Ulrich (1897, p. 1053) as follows:

Related to T. salteri, but has a shorter and smaller spire, and proportionally larger and much more ventricose body whorl. The lower margin of the peripheral band also is more obscure, the upper slope more concave, the lines of growth very fine and more nearly vertical, the inner lip not so straight and the aperture less oblique and more ovate. The specimen illustrated may be said to be of the average size, though we have an interior cast of one that was fully twice as large.

As its original locality is cited the Utica group of Cincinnati, Ohio and vicinity. Bassler (1916, p. 1302) refers it to the Southgate member of the Eden.

We have observed but two specimens of this rare and unobtrusive gastropod, one in the Moose creek section (station 11–12) and one in the Rust collection of fossils of the Whetstone Gulf formation from the neighborhood of Rome.

Genus **Strophostylus** Hall

Strophostylus gregarius nov.

Plate 9, figure 15

The dark gray, argillaceous shale transitional from the Utica to the Frankfort beds, contains at Holland Patent, N. Y., aggregations of small gastropod shells (United States National Museum no. 34475) that at first remind one of Holopea through their ventricose, smooth volutions but under the lens are found to be sculptured with extremely fine revolving and, in some parts also vertical lines, both barely visible under a strong lens. This sculpture would suggest reference to Cyclonema, the general form, and especially a certain irregularity of coiling indicate that this species is a representative of Strophostylus, which also has a cancellated surface.

Shell minute (2.5 mm high, 3 mm wide), broadly conical; apical angle about 70°, whorls three, rapidly increasing from the knob-shaped first volution; ventricose; upper half of last volution somewhat flatter than the rest of the whorl. Suture deep. Aperture not seen. Surface furnished with fine revolving lines (about 20 in 1 mm), or in other parts with equally fine oblique growth-lines and also wit some coarser rugae.

Strophostylus gregarius is sufficiently distinguished by its small size and extremely delicate sculpturing from its congeners, and the species of Cyclonema, not to require any further elaboration of the differences.

Genus **Holopea** Hall

Holopea varicosa nov.

Plate 9, figures 16 and 17

Descriptions. Shell of small size, with height and width about equal, consisting of about four fairly rapidly enlarging ventricose whorls. Umbilical perforation not observed. Suture distinctly impressed on all whorls. Aperture not observed. Surface furnished with relatively strong, nearly straight varices crossing the whorls from the suture with a slight backward direction; and besides with extremely fine, closely arranged striae both on the varices and the intervals.

Measurements. Height 15.3 mm; width 15.5 mm; height of third volution 4.3 mm; height of last volution 9.5 mm.

Horizon and locality. Upper Utica shale at Holland Patent, Oneida county, N. Y.

Remarks. This species recalls, in the surface sculpture, the Holopea symmetrica Hall, from the upper Trenton of New York. It is, however, larger and its whorls enlarge more rapidly. In general outline it resembles more Holopea obliqua Hall, also an upper Trenton form, which, however, has less distinct varices and enlarges still more rapidly.

Incertae sedis

Cyclora (Hall)

Plate 10, figures 1-4

Certain beds of the upper Lorraine contain minute gastropods referable to the genus Cyclora. The latter was erected by Hall (1845, p. 294) for minute shells from the Cincinnati beds, occuring often in great numbers in the strata. He described two species and four more have been added by Miller, Ulrich and Foerste.

It has been suggested by Ulrich and Scofield (1897, p. 847) that the species of Cyclora may be " dwarfed forms of Holopea or Cyclonema and Lophospira," a view which seems to be supported by the occurrence of our forms in a pronounced microfauna at Worthville. Cumings (1908, p. 962) states that there is still some doubt whether these species may not be the young of other species of gastropods, but sees in their occurrence " in enormous numbers at horizons where other species are rare or lacking, a fact which admits of the interpretation that they are good species."

The presence of the following types in the New York Lorraine is suggested by our material:

1 **Cyclora minuta** Hall (1845, p. 294). This species is probably represented by specimens from station 22*a* at Worthville, N. Y., one of which is reproduced in plate 10, figures 1 and 2. Hall describes the species as follows:

> Smooth; volutions, about three, rapidly expanding towards the mouth; spire moderately elevated; aperture round and well defined. The last whorl forms the principal part of the shell.
>
> Height of shell 1/30 to 1/20 of an inch.

Cycloras of similar outline (plate 9, figure 1) have also been noted in the characteristic brown weathering upper Lorraine drift material, derived from the impure limestone beds. The specimen figured is in a boulder with Rafinesquina mucronata Foerste.

Bassler records C. minuta as occurring in the Mohawkian and Cincinnatian of numerous American localities.

2 **Cyclora parvula** Hall (1845, p. 294) This species, of equal range and geographic distribution with the preceding, is represented by specimens occurring at locality 23 (zone VI) of the Lorraine gulf section, and one of which is reproduced in plate 10, figure 4.

It is, according to Hall, characterized by the following features:

> Spire elevated, volutions about four, smooth; first whorl angulated upon the center towards the aperture; outer edge of the aperture projecting downwards. Height of shell 1/15 of an inch.

3 **Cyclora** cf. **pulcella** Miller (1882, p. 231). Certain specimens found at Worthville associated with C. minuta, suggest by their more rapidly swelling volutions (see plate 10, figure 3) a reference to C. pulcella Miller, a species that is, however, so far known only from the Richmond beds.

Order **Opisthobranchia**

Suborder **Pteropoda**

Family **Hyolithidae** Nicholson

Genus **Hyolithes** Eichwald

Hyolithes pumilus nov.

Plate 10, figures 5 and 6

Description. Tube of small size, rapidly expanding, at an angle of about 18 degrees. Convex side with a distinctly arched median keel, bounded by one (or two?) sharp grooves. Flat side extended beyond the arched side in a rounded projection. Surface provided with very fine transversal growth-lines. Cover not seen.

Measurements of holotype. Length 4.2 mm, width 1–4 mm.

Horizon and locality. In zone I of the lower Lorraine, (Whetstone Gulf) shale, in the Whetstone and Lorraine gulfs.

Remarks. The sole interest of this minute form consists in its being the only known representative of the genus Hyolithes in the Lorraine beds. There are no species of Hyolithes described from the Cincinnatian group of Ohio and from the Richmond two species; H. parviusculus Hall and H. versaillensis Miller and Faber. The present species is distinguished principally by the extension of the flattened side which makes it a Hyolithes s. str., while the other two species belong to Orthotheca Novak, in which the anterior end is abruptly terminated. Hyolithes pinniformis Ruedemann, a species of the Canajoharie shale, while equally small, is more slender in outline.

Suborder **Conulariida**

Family **Conulariidae** Walcott

Genus **Conularia** Miller

Conularia hudsoni Emmons

Plate 10, figures 7 and 8

Original description (Emmons 1855, p. 208).

> Pyramid elongated; sides equal or subequal; transverse furrows meet in the middle of a face at an angle of 130 degrees. The edges of a side diverge at an angle of about 25 degrees. Both the transverse and the longitudinal striae are stronger than those of the C. trentonensis; there being more than twice as many in the latter as in the species under consideration. The markings have a general resemblance to the C. trentonensis; excepting that they are much coarser and the fossil is much larger. Lorraine shales, Lorraine, Jefferson county. Cabinet of Williams College.

Professor Cleland writes me that the holotype of C. hudsoni can not be found, Emmons' collection not having been kept together. The State Museum contains the single specimen, here figured, less complete than Emmons' type, but sufficient to corroborate his statements. There can be little doubt that C. hudsoni is very closely related to the C. trentonensis and the fact that Hall in the tabular list (1847, p. 329) cites the latter species as doubtfully occuring in the " Hudson River group ", suggests that he identified C. hudsoni with his C. trentonensis.

A comparison of our specimen, which in the case of the loss of Emmons' holotype would have to be considered a neotype of the species, with C. trentonensis shows that both are equally slender, that the apical angle of the sides of the pyramid is less than 20 degrees, about 17 degrees in both, and judging from Emmons' figure, it was no more in his type, notwithstanding the fact that he gives 25 degrees as the angle. The sculpture is entirely identical in character differing only in coarseness as stated by Emmons. In C. hudsoni there are in the space of 10 mm about 15 transversal striae near the middle line and about 19 near the edges of the sides, while in C. trentonensis the corresponding figures are 20 and 23. Emmons' figure gives about 12, which would not quite agree with his statement that there are more than twice as many lines in C. trentonensis as in C. hudsoni. It is clear from this that C. hudsoni differs only in grade from the earlier species and partakes more of the character of a later mutation of the Trenton form than of a distinct species.

The exact horizon of Emmons' type is not known; it is cited as coming from Lorraine. If the village is meant, that would place the species in the upper Lorraine (Pulaski) formation. The Museum specimen also lacks a label that would definitely indicate its horizon and locality. It indicates, however, by the sandy matrix and its rusty brown color that it was derived more probably from the Pulaski than from the Whetstone Gulf formation.

Conularia trentonensis Hall mut. **latior** nov.

Plate 10, figure 9

The Collingwood shale at Collingwood, Ontario, contains a mutation of the Trenton species which, while retaining the exact sculpture so characteristic of that species, possesses a larger apical angle. While the angle formed by the marginal grooves, according to the Trenton material before us and also according to the figures published, averages 20 degrees and is frequently 18 degrees, that of the Collingwood mutation is distinctly greater and amounts to 25 degrees on both faces seen, the faces having been equal.

This mutation connects the Trenton form with the Lorraine species C. hudsoni Emmons which also bears the peculiar sculpture of C. trentonensis but in a coarser development. On the other hand, there occurs a variety of trentonensis in the Schenectady and Snake Hill shale that has a sculpture twice as fine as C. trentonensis (see var. multicosta Ruedemann, 1912, p. 115).

C. trentonensis and its subspecies were widely distributed though never common; they have been recorded in the Trenton from New Jersey to Iowa and from Canada to Pennsylvania and Virginia where Bassler has found it in the basal Martinsburg shale (see Bassler 1920, p. 321). In Scandinavia this type of Conularia sculpture appears still earlier than here (see Holm, 1893, plate 4), while in England (Slater, 1907) similar forms are not known until the Silurian.

Conularia granulata Hall

Plate 10, figure 10

The upper Utica shale near South Trenton, Oneida county, N. Y. (United States National Museum, no. 23774) has afforded the proximal portion of a Conularia that is characterized by an extremely fine cancellated surface-sculpture, consisting of intersecting transverse and longitudinal lines, which are so delicate that 18 to 20 of the transverse lines are counted in 1 mm and the longitudinal ones are still finer. This is the surface-sculpture seen in the upper Trenton species Conularia granulata Hall, where it is also so fine that it is " scarcely visible to the naked eye." In our specimen it is invisible to the naked eye, but then this is only the proximal portion which usually carries a finer sculpture than the mature parts.

In the larger part of the fossil the interior cast of the sculpture is seen, which appears as intersecting raised lines; at the apex, however, a small portion of the exterior is preserved and this shows the extremely fine granulations, resulting from interesecting fine striae. Here also a very small piece of the marginal groove is seen, which is well marked, with smooth and prominent edges. The facial grooves are faint, hardly visible; the faces apparently subequal and flat; the shell tapering at a fair rate; the apical angle measuring, as in Hall's type, about 35 degrees. The cross section seems to have been square.

Class **Cephalopoda**

Subclass **Tetrabranchiata**

Order **Nautiloidea**

Family **Endoceratidae Hyatt**

Genus **Endoceras Hall**

Endoceras proteiforme (Hall)

Endoceras proteiforme has been cited among the Utica fossils by many authors. In nearly every case the latter have, however, had in mind the species of Geisonoceras which were erroneously considered by Hall as varieties of Endoceras proteiforme because they had been found within the siphuncular sheaths of that large cephalopod. These forms are here described under Geisonoceras and they are the common cephalopods of the Utica shale.

The true Endoceras proteiforme is probably present, for example at Holland Patent, but none of the fragments of large cephalopods were sufficiently preserved to permit of a conclusive identification.

Specimens showing the characteristic rate of growth and depth of chambers of E. proteiforme occur undoubtedly in the Canajoharie shale, where we have seen them from the sections at Sprakers and the Ohisa creek.

Parks and Fritz (1923, p. 15) describe the species as occurring in the Toronto rocks of Collingwood age. From this report and from our observations at Holland Patent, it seems that E. proteiforme ranged from the Trenton into the upper Utica.

Endoceras sp.

The Lorraine sandstones at Lorraine, the neighborhood of Rome, Westernville and other places in New York afford fragments of very large orthoceracones, which, however, in nearly every case have lost their interior structure revealing only the flattened conch and the sutures, and thus leaving undeterminable their true generic reference; although from their large dimensions and close arrangement of septa we have little doubt that they will finally be found to belong to the genus Endoceras, and to be related to E. proteiforme. With present evidence at least two types can be distinguished, namely:

1 **Endoceras? lorrainense** nov. The type specimen, a fragment, is 247 mm long, 112 mm wide at the narrower and 128 mm wide at the upper end, expanding at a rate of 6.5 mm in 100 mm. The sutures are 13.5 mm apart.

A specimen in the State Museum from the Lorraine sandstone in Oswego county (probably Washingtonville) retains the siphuncle. While the specimen, flattened, is 109 mm wide, the siphuncle has an approximate width of 75 mm, thus occupying nearly three-fourths of the width of the conch, in central position. Likewise the original of O. coralliferum (in Palaeontology of New York, volume 1, plate 86, figure 1*d*,), from the Lorraine sandstone at Turin, N. Y., now in the American Museum of Natural History and kindly loaned to me by Doctor Hovey, shows at the upper end (lower in figure) the flattened section of a siphuncle occupying three-fourths of the

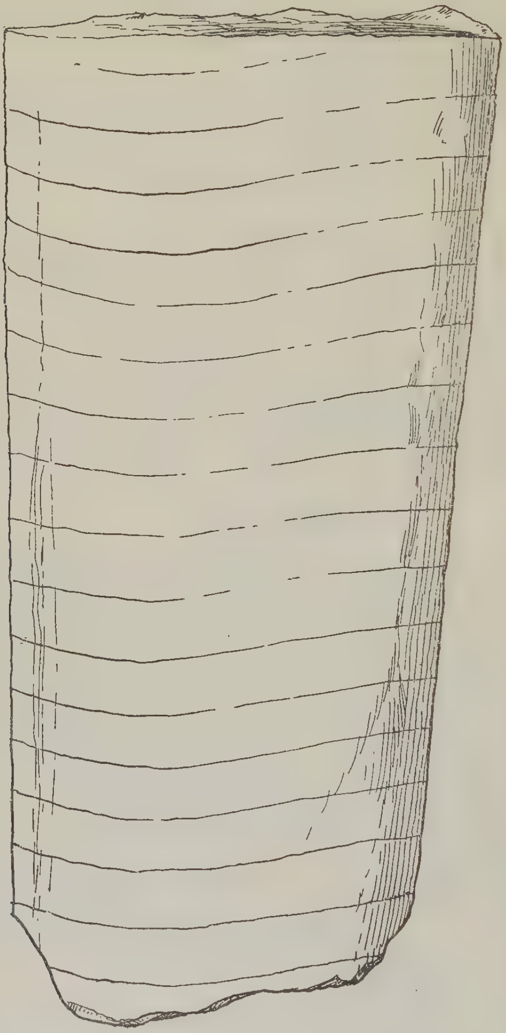

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Figure 17 Endoceras lorrainense nov. Type specimen x ½.

width of the conch. This contains one endosipho sheath. No evidence as to the length of the septal funnels and the possible reference of the species to Vaginoceras or Cameroceras could be obtained.

This species is characterized by the slow rate of growth, denoting a very slender form. The type specimen comes from the Lorraine sandstone at Lorraine, N. Y.

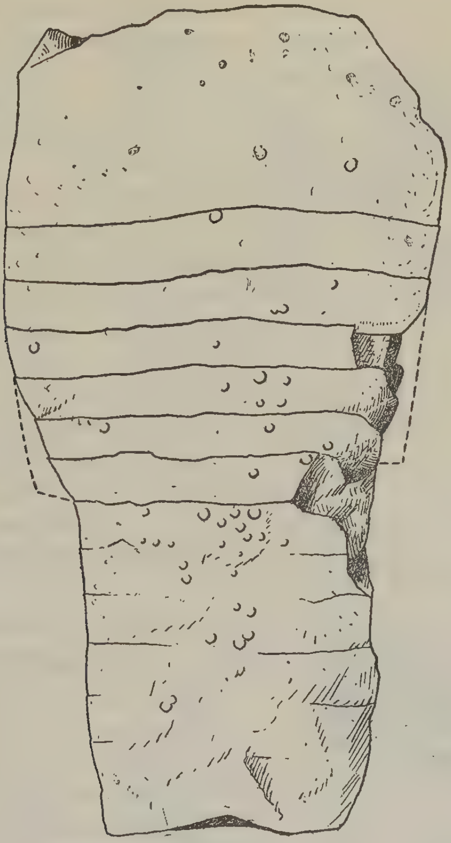

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Figure 18. Endoceras lorrainense nov. Specimen showing siphuncle at lower end. From Oswego county. x ½.

To this species apparently also belongs the fragment of an earlier portion of a conch reproduced on plate 20, figure 1. This shows a marginal siphuncle that occupies half the conch. The septa equal in depth to that of the camerae; and the surface appears to have been smooth.

If the apical end of the siphuncle figured on plate 20, figure 2 also belongs to this species, as is suggested by the spacing of the attachment lines of the septa (6.5 mm apart in a siphuncle) in reference to the width of the siphuncle, then the species may more properly belong to Suecoceras, for the fragments indicate the development of a nepionic bulb as in Suecoceras. It is extremely similar to the siphuncle of Suecoceras (?) inaequabile (Miller) figured by Foerste (1910, plate 1, figure 1) from the Waynesville formation of Ohio.

2 **Endoceras ? romanum** nov. The type specimen of this species, from the Lorraine beds of the neighborhood of Rome, is 155 mm long, 68 mm wide at one and 88 mm wide at the other end, expanding at a rate of about 13 mm in 100 mm. The sutures are 10 mm apart. This species differs from the preceding in its greater rate of expansion and closer arrangement of septa.

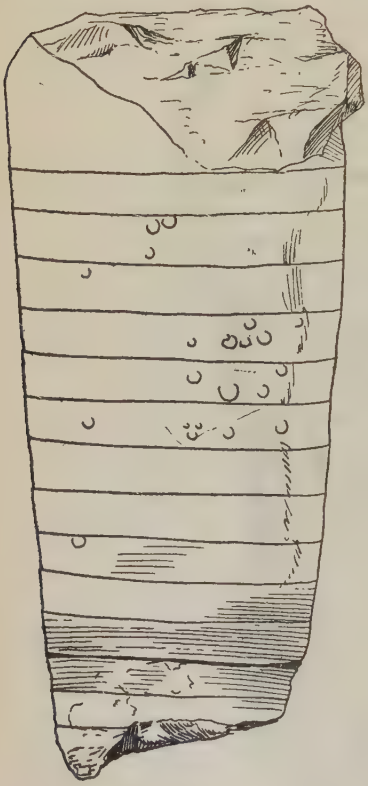

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Figure 19 Endoceras ? romanum nov. Type specimen x ½.

Endoceras ? coralliferum (Hall) emend. Rued.

Hall (1847, p. 312) has used the name "Orthoceras coralliferum" as a receptacle for various forms from the Canajoharie shale at Waterford, the Utica shale and the Lorraine beds, which have the incrustation by bryozoans as a common character. As the author of the species himself states that it "can not be characterized with precision," and the name itself does not express any characteristic feature of one of the assembled types, it would seem most practical to drop the name altogether, unless one wishes to observe punctiliously the law of priority and restrict the name to the first specimen figured, which happens to be that from the "Utica slate" at Turin. We will follow this latter course, emending Hall's species.

The original of the Utica shale specimen is in the New York State Museum (*no. 12357*). Hall's figure (plate 85, figure 3), reproduces the distal portion only of the specimen, which is here figured completely.

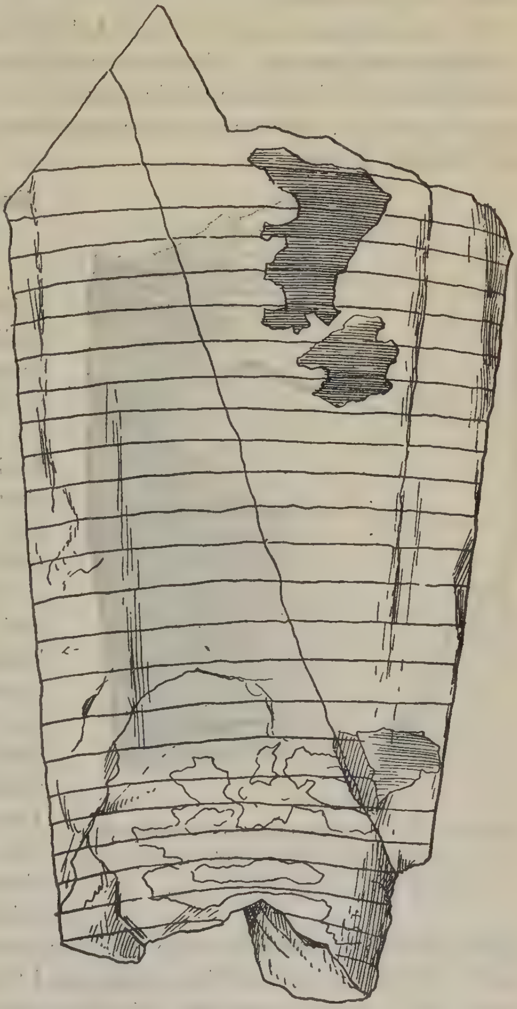

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Figure 20 Endoceras ? coralliferum (Hall). Hall's type specimen x ½. Note siphuncle at lower right end.

The specimen, a fragment of the septate portion of the conch, is completely flattened. It indicates an individual of large size, the fragment being 16 cm long; and 130 mm wide at the upper and 85 mm at the lower end, thus indicating an approximate rate of growth of 28 mm in 100 mm, or slightly more than 1 in 4. The septal sutures are very closely arranged, for a specimen of such dimensions and 9 mm apart at the wider end and 7.7 mm at the narrower one, or from one-twelfth to one-fourteenth of the width of the conch. They are broadly arched in the middle and slightly bent forward on the siphuncular side. At the lower end a smooth plate protrudes which in conjunction with a slight bulge of the conch suggests the presence of a large submarginal siphuncle, about

35 mm wide (or less than one-half the width of the conch). The relative size of this siphuncle indicates that the species probably belongs to Endoceras.

The surface was smooth or provided with indistinct growth-lines.

Horizon and locality. The horizon of this species is probably the upper third of the Utica shale (zone of Climacograptus pygmaeus), whence we have specimens before us from Turin and Holland Patent.

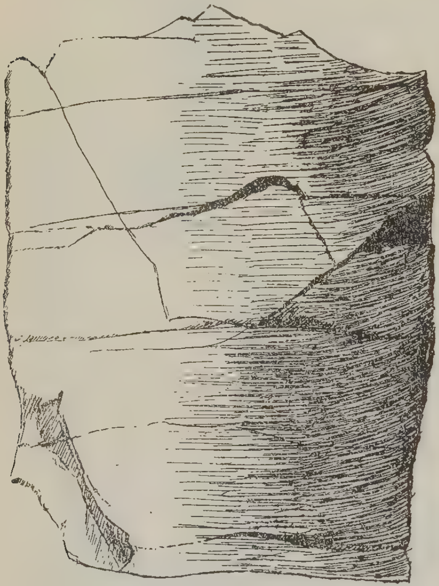

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Figure 21 Endoceras ? sp. Fragment of large form from Utica shale in Steuben creek near Barneveld, N. Y. x ½.

Endoceras perannulatum
nov.

Plate 15, figure 1

The upper Utica shale at Holland Patent, N. Y., has furnished a single specimen (United States Nat. Mus. no. 34483) of an annulated Endoceras that exhibits characters proving its specific independence from similar forms.

The conch, incomplete and completely flattened, belongs to an animal of medium or large size. It is 220 mm long and 52 mm wide at the upper end. Its rate of growth is slow, about 5 mm in 100 mm or 1 in 20. The camerae are shallow, about five being counted in a distance equal to the width of the conch; the sutures are 10 mm apart where the conch is 50 mm wide. Both the depth of the camerae and the spacing of the sutures are in the specimen inferable only from the attachment lines of the septa upon the siphuncle. The siphuncle was extremely large, occupying two-thirds of the width (34 mm where the conch is 51 mm wide); judging from the distinct upward curvature of the attachment bands (funnels) of the septa, it must have been situated close to the wall of the conch on one side. No traces of any interior structures of the siphuncle are preserved. The surface is provided with closely arranged rounded annulations (3 to 4.5 mm. apart when the shell is 43 mm wide) separated by interspaces of the same width.

Horizon and locality. Upper Utica shale at Holland Patent, N. Y.

Remarks. This species differs from the earlier (Trenton) species E. annulatum in the slower rate of growth (only one-half that of the Trenton form) and greater depth of camerae (5 in width of conch as against 7 to 8 in the Trenton form) and the much closer arrangement of the annulations.

Family **Orthoceratidae** McCoy

Genus **Orthoceras** Breyn

Orthoceras? cf. **transversum** Miller

Plate 12, figure 5

The dark gray shale near the base (zone I) of the lower Lorraine (Whetstone Gulf formation) contains the completely flattened exterior casts of small cephalopods that exquisitely retain a sharply linear transverse sculpture. None was found to retain the siphuncle or the septa (except the sutures) and their generic relations have therefore remained unknown. Some agree fairly well in rate of growth and depth of camerae as shown by the sutures with Paractinoceras lamellosum from the Pulaski shale; others have a greater rate of growth and more closely arranged septa. These latter are so close to Geisonoceras tenuistriatum Hall in rate of growth, depth of camerae and character of surface sculpture that, provided their siphuncle were known and would not exhibit any differential characters, they could be identified with that species. The same rate of growth, depth of camerae and transverse sculpture lines are also possessed by Orthoceras transversum Miller. This being an Eden species of the Ohio basin, its occurrence may well be expected in the Whetstone Gulf formation. The septa are, however, described as strongly arched (Foord, 1888, p. 16) and the siphuncle as excentric (James, 1885, p. 239), characters that have so far failed to be observed.

Associated with the transversely striated shells there occur also others with a combination of longitudinal and transverse lines, the longitudinal lines being much finer and relatively wider spaced than in G. tenuitextum. Otherwise they have the relative dimensions of that species, its rate of growth and depth of camerae.

Shells of the character here described are especially noticeable in the collections from Wood creek and the region east of Rome (Rust collection).

Genus **Geisonoceras** Hyatt

Geisonoceras tenuistriatum (Hall)

Plate 10, figures 12–14; plate 11, figure 2

The Utica fossils here referred to Geisonoceras tenuistriatum and G. amplicameratum were placed by Hall (1843, p. 311) under Endoceras proteiforme and have been cited under that name in the lists of Utica fossils by all subsequent authors, the present writer included. It appears from Hall's text that he had in mind his supposed varieties tenuistriatum, tenuitextum, lineolatum etc., of Endoceras proteiforme. These varieties are now known to be true Orthoceratidae.

Geisonoceras tenuistriatum has been described by Hall (1843, p. 209) from relatively small fragments obtained in the Trenton limestone. The Utica shale at Holland Patent has furnished specimens reaching a length of 3 dm, although slightly imperfect at both ends. The conch is a slender orthoceracone, of circular section, increasing at a rate of 11 to 12 mm in 100 mm, or approximately 1 in 10. The septa are fairly closely arranged, there being counted about five camerae in a distance corresponding to the width in the ephebic stage, and 3 to 4 in the nepionic and neanic stages; an actual measurement being a depth of 5 mm of the camerae, where the width of the conch is 25 to 30 mm. The sutures are straight transverse. The septa are fairly concave, their depth being about equal to that of the camerae. The living chamber is long, a little less than one-third the length of the entire conch. The aperture is apparently straight transverse. The siphuncle is small, about one-twelfth the width of the conch (1.5 mm where the conch is 18 mm wide) in the ephebic stage, centren, slightly excentric in the neanic stage (ventrad of center?), tubular, sometimes very slightly inflated. The siphonal funnels are very short. There are no secondary deposits in the camerae or siphuncle.

The surface sculpture is described by Hall as follows:

> The surface "is marked by regular transverse striae, sometimes appearing as if imbricated, or having one edge elevated. The longitudinal striae are not more than one-fourth as large as the transverse ones, and visible only under a magnifier; they often become obsolete and scarcely perceptible, and the transverse striae assume a slightly imbricating and lamellose structure. The transverse striae are often crowded together in bands of fasciae.

Horizon and locality. Very common in the upper Utica shale at Holland Patent and elsewhere, but passing through the entire formation. It is also a common fossil in the Canajoharie shale, which has furnished the material for the beautiful sections here figured. It further occurs in the Atwater Creek and Deer River shales.

The specimens figured by Hall on plate 85, figures 1*a*, 1*b*, 1*c* represent very well the usual occurrence of the species in the Utica shale, in the earlier growth stages, with the camerated part pyritized and the living chamber crushed and flattened. These smaller specimens sometimes cover whole beds, as at Dolgeville, above the dam, and they are the common cephalopods of the Utica shale.

Also the specimen from the Schenectady beds, figured and doubtfully referred to Orthoceras hudsonicum by the writer (1912, plate 8, figure 7) belongs to this species.

Geisonoceras tenuistriatum (Hall) var. **frankfortense** nov.

Plate 12, figure 1

Plate 12 figure 1 illustrates a specimen that was found by the writer in a sandstone slab of the Frankfort shale at the Delta dam near Rome. It is nearly related to the common Utica form Geisonoceras tenuistriatum, differing but slightly in minor features and probably representing a later mutation of that species.

While the conch appears curved, the proximal part and the living chamber are straight and the curvature is probably accidental. The conch is slender, but still more rapidly expanding than that of the typical tenuistriatum, namely, at the rate of 7 mm in 50 mm. The sutures are closely arranged and there are five camerae counted in a distance corresponding to the width of the conch; or in other words the sutures are about 2 mm apart in the mature part where the conch is about 10 mm wide. The depth of the septa about equals that of the camerae. The siphuncle is somewhat excentric and slightly nummuloidal. The living chamber, if fully preserved, is relatively shorter than in G. tenuistriatum, its length (31 mm) being about $\frac{1}{3}$—$\frac{1}{4}$ of the total length, which is 113 mm. Its apertural width is 17 mm. The surface was provided with fine transverse lines.

Although the siphuncular segments would seem to be slightly more nummuloidal than in some specimens of Geisonoceras tenuistriatum, the slender form of the conch and the absence of secondary deposits would not warrant the reference of the species to Paractinoceras or to any genus of the Actinoceratidae.

Geisonoceras tenuitextum (Hall)

Geisonoceras tenuitextum, originally described by Hall (1843, p. 210) as Endoceras proteiforme var. tenuitextum, from Trenton limestone material, has also been found to occur rarely in the lower Utica shale at Holland Patent. Hall states that it does not differ in form from tenuistriatum, but has the longitudinal and transverse striae more distinctly elevated and threadlike, being of nearly equal size in both directions.

The Utica shale specimens corroborate Hall's statement of the essential equality in form of tenuistriatum and tenuitextum and suggest that the latter may be only a variety of the former. The longitudinal striae are very sharp, fairly equidistant and number about 30 in 10 mm.

Geisonoceras amplicameratum (Hall)

Plate 11, figure 1; plate 12, figures 2 and 3

Hall (1843, p. 205) has described this species as a member of the Trenton limestone fauna as follows:

> Teretely cylindrical, extremely elongated, very gradually tapering; outer chamber profound; septa distant about one-third the diameter, very convex; siphuncle excentric, small; surface section circular. The peculiarities of this species are its great length, and very gradually diminution from the larger extremity, and the distant and very convex septa, which seem sufficient to distinguish it from all other known species in the rock.

The Utica shale at Holland Patent has furnished a fine series of specimens of this species, some of which attain a length of 5 dm (almost 1½ feet) but specimens showing a width of the chambered portion of 40 mm indicate others still larger by one-quarter. The conch is an extremely slender orthoceracone of circular section, increasing at a rate of 6 mm in 100 mm or approximately 1 in 20. The camerae are fairly deep, there being but three camerae in a distance corresponding to the width in the ephebic stage; an actual measurement being a depth of the camerae of 8.5 mm where the width of the conch is 25 mm. The sutures are straight transverse. The septa are about half as deep as the camerae. The living chamber is very slender, four times as long as wide and amounting to one-fourth the length of the conch. The aperture is straight transverse.

The siphuncle is small, about one-sixth the diameter of the conch (about 4 mm in the ephebic stage), excentric in position (ventrad of center?), apparently tubular; empty.

The surface is practically smooth, or only provided with faint growth-lines.

Horizon and locality. Most common in the upper Utica shale at Holland Patent; possibly also present in the Atwater Creek shale.

It is very probable that this species is represented by fragments of a gigantic cephalopod found by the writer in the Utica shale at the Steuben creek, Oneida county. These specimens belong to a slender orthoceraconic form with camerae so deep that the sutures are apart about one-third the width of the conch; proportions that correspond with those of G. amplicameratum rather than with those of any of the Endoceratidae.

Geisonoceras strigatum (Hall)

Specimens from the upper Utica shale at Holland Patent, although but imperfectly preserved, show sufficient characters to refer them with a fair degree of confidence, to Geisonoceras strigatum (Hall), a Trenton fossil. The striae numbering about 16 in 10 mm, are spaced very regularly. The sutures are arranged slightly closer than they are stated to be by Hall, there being counted six camerae in a distance equal to the width in the ephebic stage, instead of five, but we have before us finely preserved typical Trenton specimens of G. strigatum, also showing this somewhat smaller depth of the camerae.

The writer has shown in another paper (1919, p. 79 ff) that finely preserved specimens of G. strigatum now in the State Museum exhibit color lines (light brown) alternating with equally broad white lines; that the pigment within the calcareous shell in the color lines protects these from dissolving and weathering as fast as the white lines, thus producing the apparent longitudinal sculpture of G. strigatum. The actual surface sculpture of the practically smooth conch consists, in addition to the faint transverse growth lines, of extremely fine longitudinal lines, so delicate that they are with difficulty visible under the lens and number 8–10 in the width of one color band. This sculpture and the other characters have proved the identity of G. strigatum with G. tenuitextum (*op. cit.* p. 81). It has also been shown that these color bands are found only on the dorsal side of the conch, thus indicating that the animal inhabiting the shell habitually carried it in horizontal position, either swimming or dragging it over the bottom of the sea.

Geisonoceras spec. indet.

Plate 12, figure 4

The specimen here figured, together with several fragments, indicate the presence of a further species of Geisonoceras in the upper Utica shale at Holland Patent, principally characterized by its considerable rate of expansion (20 mm in 100 mm) and the strong development of the transversal striae, which are evenly spaced, numbering about 14 in 10 mm.

Family **Cycloceratidae** Hyatt

Genus **Cycloceras** McCoy

Cycloceras persculptum nov.

Plate 13, figure 1

Description. Conch of medium size, orthoceraconic, rapidly expanding (rate of expansion 23 mm in length of 100 mm). Living chamber wide and short, about $1\frac{1}{2}$ times as long as wide (at aperture), occupying about one-third the length of the conch. Aperture straight transversal. Camerae shallow, five occupying in the ephebic stage a distance equal to the width of the conch. Sutures straight transversal; septa as deep or somewhat deeper than the camerae. Siphuncle centren, or nearly so, small (about 1.5 mm), tubular. Surface sculpture consisting of low annuli, about 2 mm apart in the ephebic stage; sharp transversal lines, separated by flat interspaces of twice their width, and numbering about 12 in 10 mm in the mature conch.

Horizon and locality. Upper Utica shale at Holland Patent, N. Y.

Remarks. This species does not appear to be represented by any near relative in the Trenton fauna. While the character of the annuli would suggest a comparison with Cycloceras olorus (Hall), the species before us is at once distinguished from this and most other annulated Trenton forms by the greater rate of growth, as well as the character of the transverse lines.

Family **Kionoceratidae** Hyatt

Genus **Spyroceras** Hyatt

Spyroceras bilineatum (Hall)

Plate 13, figures 2 and 3

The presence of this well-known Trenton species in the Utica shale is proved by a single specimen obtained at Holland Patent,

N. Y. This is 52 mm long; its rate of expansion is about 6 mm in 100 mm. The annuli number three in a distance corresponding to the diameter of the conch; they are separated by intervals equal to their own width. The longitudinal striae alternate in size, are .8 mm apart and continuous. The camerae are shallow, numbering three to four in the width of the conch, the sutures apparently straight transverse, the septa shallow, their concavity about equal to the depth of the camerae. The living chamber has not been observed.

It is possible that the Utica form is a mutation of the Trenton species. This is at least suggested by the somewhat greater distance between the annuli, but can not be established until the revision of the Trenton material of S. bilineatum, which at present seems to comprise several types of annulated forms.

Genus **Protokionoceras** Grabau and Shimer

Protokionoceras oneidaense (Walcott)

Plate 10, figure 11; plate 16, figure 1

Walcott (1879, 1883 p. 22) has described from the Utica shale of the town of Trenton, Oneida county, N. Y., which includes the neighborhoods of Holland Patent and South Trenton, the proximal portion of a slightly curved cephalopod conch that is given the name of "Orthoceras oneidaense." It is described as "a very slender, finely cancellated, shell different from any other known to the author." The natural size figure of the holotype shows vertical striae only, while the enlargement of the sculpture (plate 1, figure *7a*) gives sharp intersecting vertical and transversal striae of two sets, a coarser and a much finer intercalated set. The coarser striae form small mucros at the points of intersection.

The United States National Museum contains four larger specimens (no. 34480) from Holland Patent, identified by Walcott with his species. They are hence metatypes, uniting the derivation from the horizon and locality of the holotype with that of the determination by the author of the species. These afford the following description:

Small slender orthoceracone, slightly curved in the neanic stage; largest specimen observed (imperfect at both ends) about 100 mm long and 23 mm wide. Section circular (?). Conch increasing at a rate of 22 mm in 100 mm or approximately 2 in 10. (The neanic stage figured by Walcott is much more slender and shows only half that rate.) The septa are very closely arranged, there being counted eight camerae in a distance corresponding to the width in the wider portion and three in the youngest portion observed. The depth of the camerae varies between 2 and 3.5 mm where the conch is 20 mm wide, most of the camerae being nearer the smaller figure. The sutures are straight transverse. The depth of the septa is not known.

The living chamber is not known. The siphuncle is small, apparently tubular and subcentren.

The surface sculpture consists of sharp-keeled vertical carinae with concave interspaces averaging 15 in 10 mm. The finer intercalated striae are only faintly visible in spots and therefore in the later growth stages much subdued or entirely obliterated. A partly pyritized specimen shows, however, in an earlier growth-stage very distinctly both the transverse lines and the modes of intersection, the transverse lines being less sharp and regular and more crowded than the longitudinal lines.

Horizon and locality. Upper Utica shale at Holland Patent, N. Y.

Remarks. This species is readily distinguished from Geisonoceras tenuitextum by the preponderance of the longitudinal carinae over the transverse striae, the greater rate of growth and the closer arrangement of the sutures. This form, by the preponderance of the longitudinal sculpture lines, points to the development of the Kionoceratidae from Orthoceratidae having the surface sculpture of tenuistriatum through tenuitextum; the three, tenuistriatum, tenuitextum and oneidaense, forming a continuous series from forms with purely transverse sculpture to such with prevailing longitudinal sculpture, for which the generic term Protokionoceras has been proposed by Grabau and Shimer (North American Index Fossils, 1910, 2:58).

Family **Trocholitidae** Hyatt

Genus **Trocholites** Conrad

Trocholites ammonius (Conrad)

Plate 17, figures 1–5; plate 18, figures 1–3

Trocholites ammonius was first very briefly described but not figured by Conrad (1838, p. 119) from a specimen from Newport, N. Y. Emmons later (1843) furnished two figures, in the Report of the Survey of the Second Geological District, one of a Trenton limestone specimen (p. 392, figure 1) and one of a Utica shale specimen (p. 279, figure 1). The first one to describe and figure the species adequately was James Hall in the Palaeontology of New York, volume 1, 1843, p. 192–309. His description is as follows:

> Discoidal; volutions in the same plane, about four, rounded, slightly concave on the ventral side, gradually enlarging in size towards the aperture, which is slightly expanded; surface marked by lamellose irregular and oblique transverse striae or ridges, between and upon which are finer lamellose striae, covering the outer surface, and giving it a peculiar textural or netted appearance; striae meeting in an arch upon the back [external side, which is the venter] septa direct, or slightly undulated on the dorsal [ventral] side; outer chamber large; siphuncle ventral [internal or dorsal]. . . The peculiar character of the surface is produced by the numerous crowded edges of lamellae, which, in perfect specimens, are somewhat regularly undulating. Where the shell is partially exfoliated, the textural character of the surface is destroyed, and it is only marked by fine oblique striae. The stronger striae are very variable, being sometimes so prominent as to deserve the name of ridges, and at other times are only slight undulations; while in many instances they are not at all developed, and the surface is marked only by the finer lamellose striae.

Hyatt has more recently (1894, p. 487) described very fully the structure of the species, especially that of the peculiar surface sculpture. He states:

> This species . . . has a very peculiar, rough, fretted surface; and only very few specimens show longitudinal lines such as are described and figured in T. planorbiformis by Conrad. This surface is due to the minute crenulations or waves in the outlines of the projecting edges of the laminae of growth. When these are wide enough apart we can distinguish crenulated transverse lines; when too close they interfere and the regularity and continuity of the lines are broken into a multitude of more or less discontinuous, short lines. Sometimes a network of lines is formed by the regularity of the intersection of the crests of the crenulations in successive laminae. This cuticular ornamentation is so easily destroyed that it is often present only in parts of the same specimen.
>
> Longitudinal lines may be seen through it, but, as stated by Hall and observed by the writer, these are rarely present in the New York specimens. They do, however, sometimes exist all over the abdomen and sides, and are well defined in specimens in which the cuticular corrugations are absent.
>
> The lines of growth are extremely crowded, and what are called the costae occur at wider intervals and more irregularly. They are probably the traces of former apertures. These are more prominent in some specimens than in others, but never seem to have the aspect of true foldlike costations.
>
> The lines of growth form deep, broad sinuses on the venter; rise into lateral crests on the sides, sinking towards the lines of

involution, and forming a sinus in the contact furrow. These are parallel to the outlines of the apertures, but these last not infrequently have shallow, broad constrictions and slightly projecting or trumpet like lips in full-grown whorls.

The specimens of T. ammonius from the same locality may vary from very broad-whorled forms to those with much narrower almost cylindrical whorls, the former being slightly deeper umbilici and the latter being shallower, as in T. circularis. The venter and sides are, however, almost invariably projecting and rounded, unless angulated by compression, whereas in circularis there is a distinct tendency towards truncation or flattening of the abdomen and sides.

The sutures in the ephebic stage may be nearly straight, but there are in most specimens broad ventral lobes, saddles at the abdominal angles, lateral lobes and saddles on the umbilical zones and lobes in the contact furrow. These inflections are, however, always slight, and the sutures give the impression of being almost straight in most specimens.

The contact furrow is distinct but not deep in the ephebic stage and continues to be present in the aperture of the whorl, which is never free.

Both Hall's and Hyatt's descriptions are entirely drawn up from specimens coming from the Trenton limestone of New York. Hall, however, reports that the species passes upward into the Utica shale, citing East Canada creek, Canajoharie, and Cold Spring on the Erie canal as localities where it occurs. The black shale at all of these outcrops lies however below the typical Utica shale, is the Canajoharie shale and of Trenton age.

Ami has cited T. ammonius as occurring in the black shales of Quebec and Ontario in Canada and Bassler (1915, p. 1298) records its occurrence in the Trenton of West Covington, Ky.

As far as we are aware, no Trocholites is found in the typical Utica shale except in the upper Utica beds at Holland Patent, N. Y. From this well-known locality we have before us a remarkable series of specimens of which we have figured several showing features hitherto not fully illustrated.

While it is very difficult to compare the relative dimensions of the flattened and crushed shale specimens with those of the Trenton limestone, it is apparent that the rate of growth of the conch was the same in both; the dorsal-ventral diameter being about doubled in one volution in the ephebic stage, and that, judging from the amount of overlap on the preceding whorls, the sections were essentially alike. A comparison of figures *a* and *b* with *c* and *d* would suggest wide differences in the rate of growth among the Holland Patent specimens, but these differences are probably the expression, in compressed form, of the variability in section, mentioned by Hyatt, between broad-whorled and cylindrically whorled variants, the former overlapping wider on the preceding whorls and thus having the appearance of those represented in figures *a* and *b*.

In size the Holland Patent specimens seem to have far surpassed the Trenton ancestors, as is evidenced by figures *a* and *c;* and other specimens, the diameter of which reached 75 mm. The living chamber is a little less than one-half of a volution in length (figure *c*), as already stated by Hyatt (*op. cit.* p. 484) for the Trenton material, and the aperture was expanded trumpetlike with lateral crests, as is well shown in the original of figure *b*. The sutures correspond in curvature to those of the Trenton specimen. The siphuncle is not observable in the shale material.

The surface sculpture is composed in the nepionic and neanic stages of some sharp curved costae (see plate 17, figure 4) which disappear in the ephebic stage, while others are smooth in the same stages. All have the fine anastomosing fretted lines, which vary considerably in the same specimen (see plate 18, figure 1*a*, 1*b*), often strikingly resembling the markings left by a Paleschara, while in other portions they are so crowded as to appear as an obscure mass of subparallel lines, and in others again they have the appearance of short parallel dashes (see plate 18, figure 1).

Inasmuch as the considerable larger size of the Holland Patent specimens is due to the development of a fifth volution, the Trenton individuals having but four, and this larger size goes hand in hand with a somewhat wider spacing of the sutures, (about three camerae in the diameter of the conch against four in the Trenton form), indicating a more rapid advance of the animal in the conch, it seems to us that this difference in the rate of life is worthy of recognition and we therefore propose to distinguish the Utica mutation as mut. major (plate 17, figures 1–3; plate 18, figures 1–2).

Likewise the variants with wide overlapping of the successive volutions and correspondingly narrower and deeper umbilicus are so distinct from the typical Trenton forms, as they are figured by Hall, that they should be recognized as a variety to be known as var. angustiumbilicatus (plate 17, figure 5; plate 18, figure 3).

In size attained and general aspect, especially the stronger development of the costae the Utica form here described, would seem to be closer to the Lorraine species T. planorbiformis than the Trenton species T. ammonius. As a matter of fact it occupies an intermediate position between the two, which in themselves are but little differing. Hall (1847, p. 310) could cite as differences only the frequently stronger transversal and longitudinal ridges and the larger size of the Lorraine form. By these criterions the Utica form could be with propriety referred to the later Lorraine form. T. planorbiformis, according to the material before us, has a somewhat greater rate of growth, so that it about doubles its height in one volution, while T. ammonius requires from one-quarter to one-half a volution more for the same increase. We therefore prefer to connect the Utica form with the earlier species.

The occurrence of the same peculiar sculpture upon the Trenton, Utica and Lorraine forms, as well as the general habitus leave no doubt that all three are closely related and form a distinct genetic line.

Trocholites planorbiformis (Conrad)

Plate 16, figure 8; plate 18, figures 4 and 5

Trocholites planorbiformis was first briefly described and figured by Conrad (1842, p. 274) as follows:

> Volutions higher than wide, longitudinally striated, and with oblique obtuse, transverse lines, approaching at an angle but rounded on the center of the back; apex profoundly depressed; back of the large volution flattened; aperture much longer than wide. Locality, near Grimsby, Upper Canada, in Salmon River sandstone.

Hall (1843, p. 310) described the conch as " depressed, orbicular or planorbiform," having four or five volutions, which are wider than deep, a deep umbilicus, lunate aperture and elliptical section, which is concave on the inner (dorsal) side. He found the surface to be " marked by obliquely transverse ridges, which bend backwards, forming a broad curve on the dorsal line, longitudinally striated with rounded lines." He adds that the surface is in all his specimens exfoliated and the surface sculpture destroyed, that the character of the shell is much as in T. ammonius and that he was disposed to regard it as a variety of the same, but that he has rarely found the transverse and longitudinal lines so strongly marked in the Trenton specimens, and that the latter are also smaller. Hall records the species from the central part of the " Hudson River group " at Turin and from Pulaski, stating that all the New York specimens are crushed.

Foord (1891, p. 48) has later pointed out that various British cephalopods which by Salter, McCoy and Blake have been referred to T. planorbiformis, in some cases surely, in others most probably belong to different species,[1] but he himself has referred to this species forms from the Trenton limestone of Montmorency and Lorette, near Quebec, which belong to another species, and later have been described by Hyatt (1893, p. 486) as T. canadensis; a fact pointed out by Whiteaves in his paper on the Canadian species of Trocholites (1904). According to Whiteaves no more specimens than the two types from Grimsby have been found in Canada and Foerste has (1916) also failed to find the species there in his thorough collecting, although he obtained it in place at Pulaski.

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[1] One of these was later described by Hyatt as T. blakei.

Hyatt (1894, p. 490) did not study this species and is inclined to let both its distinctness from T. ammonius and the identity of T. planorbiformis Hall with T. planorbiformis Conrad rest on Hall's authority who had seen Conrad's types.

From our New York material we infer that T. planorbiformis in size attained, number of volutions and rate of growth was close to the Utica form T. ammonius major, and that on the specimens the fretted surface is observable. The aperture (plate 18, figure 4) is expanded as in T. ammonius, likewise the two agree in the curvature and spacing of the sutures. The growth-lines (see plate 18, figure 5) indicate a well-developed hyponomic sinus. Also the differentation between forms with wide and with narrow umbilicus was continued into Lorraine time (compare plate 16, figure 8, and plate 18, figure 4). The varices and costae are, in the ephebic stage, more crowded and, in some specimens, more prominent than in T. ammonius. The longitudinal lines appear in specimens which retain the rather thick shell, as black color bands, which seem to develop into revolving ridges through weathering. According to Hall and Hyatt longitudinal lines are also seen, though very rarely, on the Trenton specimens of T. ammonius, and Hall states that they are never as distinct as in T. planorbiformis; they may therefore also in that earlier species represent color-bands but less developed. The difference in rate of growth has been discussed under T. ammonius.

T. planorbiformis occurs in the Pulaski beds at Pulaski and Lorraine village (see stations 17 & 21*a*), but has not yet been found in the middle and upper Utica and Whetstone Gulf or lower Lorraine formations. It is thus separated by a considerable time interval from T. ammonius.

Family Actinoceratidae Saemann

Genus Actinoceras Bronn

Actinoceras crebriseptum (Hall)

Plate 13, figures 4–6; plate 14, figures 1–4; plate 16, figure 7

Hall described this form in the Palaeontology of New York, volume 1, 1847, p. 313, briefly as follows:

> Elongated, conical, somewhat rapidly tapering to an acute apex; septa numerous, approximate, deeply arched, distant about one-seventh the diameter; siphuncle excentric, enlarging in each cell and contracting at its passage through the septum; section circular; surface marked by longitudinal lines, which are visible in the cast.

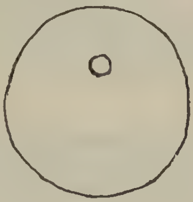
This description is accompanied by fairly accurate drawings (*op. cit.* plate 86, figure 2*a*; plate 87, figures 2*a*–*e*). Material which has been secured in the limestone bands at Pulaski — some of the best of it was kindly given to us by Doctor Foerste — allows the following additions to our knowledge of the species. The shell is an orthoceracone, with subelliptical section, the major and minor diameters of which are approximately as 7 : 8, its rate of growth is about 14 mm in 100 mm in the earlier, and 18–22 mm in the same length in later growth-stages, corresponding to an angle of about 10 degrees to 13 degrees. Fragments indicate that the conch may have reached a length of a foot or more. The camerae number six in the major diameter of the conch in the earlier, and seven in the later stages. They are hence very shallow and the sutures closely arranged. The depth of the septa equals that of 1½ camerae. The sutures are arched slightly upward on the siphuncular side and gently downward on the opposite side.

In older individuals the camerae are half filled by organic calcareous deposits upon the proximal sides of the septa and pseudosepta are sometimes developed.

The siphuncle is strongly excentric, being removed a distance equal to its diameter from one, and a distance equal to 2 to 3 times the diameter from the other side. It is less than one-quarter the major diameter of the conch in width, strongly nummuloidal; the segments of compressed globular form in the mature portions of the conch; in the earlier states spherical or less nummuloidal and liable to be more inflated distally, giving a heart-shaped section (see plate 19, figure 3). The organic deposits, forming the rosettes aggregate around the short funnels thus as to form a larger upper and a smaller lower segment (see plate 13, figure 5) and a fairly wide, regular endosiphuncular tube. Radiating tubuli (see plate 13, figure 4) are developed in this organic deposit as in other species of Actinoceras.

The shell was thick (about 1 mm where the major diameter is 25 mm), provided only with fine transverse lines on the outside. The inside and especially weathered specimens show continuous longitudinal lines which, in the weathered specimens, seem to originate from the composition of the shell of longitudinal bands of different hardness.

Orthoceras (Loxoceras) milleri Foerste (1910, p. 76) from the base of the Cincinnatian (Perryville bed of Kentucky) is extremely similar to the species before us.



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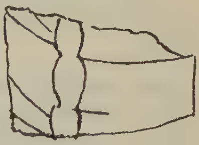

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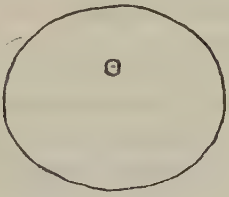

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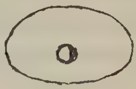

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Figures 22 and 23 Actinoceras crebriseptum (Hall). Two sections of same specimen. Natural size. From Lorraine drift (U. S. National Museum).

Figure 24 Paractinoceras lamellosum (Hall). Section of fragment, natural size.

Figure 25 Paractinoceras pusillum nov. Section of conch (compressed). Natural size. From Lorraine drift. (U. S. National Museum.)

Horizon and locality. A. crebriseptum is a common fossil in the lower and middle Pulaski beds at Pulaski, the Lorraine Gulf, Turin, etc. but it has also been collected near the top at Salmon River falls. Foerste has not found it in Canada and it seems very doubtful whether the specimens figured by Barrande (1870, plate 434, figures 6–8) under this name from Canada, (*fide* Billings) actually belong here, for not only is the rate of growth less rapid, and the section circular, but also the sutures are farther apart and the siphuncular segments less nummuloidal, suggesting a reference of his material to O. lamellosum Hall. Nor is it certain that the Canadian specimen figured by Billings (1863, p. 218, figure 228) belongs to this species, for its camerae are relatively deeper, the siphuncle smaller and less nummuloidal.[1] Foord (1888, p. 173) mentions a specimen (an imperfect fragment) from Cincinnati, also to be considered as doubtfully belonging to A. crebriseptum.

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[1] Parks and Fritz (1923, p. 20 ff) have meanwhile identified with this species material from the Lorraine of Toronto, belonging with that described by Barrande and Billings.

Genus **Paractinoceras** Hyatt

Paractinoceras lamellosum (Hall)

Plate 14, figures 5 and 6; plate 15, figure 2

The species here referred to Paractinoceras was originally described by Hall (1847, p. 312) as Orthoceras lamellosum as follows:

> Slender, very gradually tapering to an acute point. Septa distant from one-fifth to one-fourth of an inch, having a convexity about equal to their distance from each other; siphuncle slightly excentric; surface apparently lamellose or subimbricate.

It is recorded as being of " frequent occurrence in the calcareous portions of the Hudson River group " and cited from Turin, Lorraine, Pulaski, and near Rome.

While in the description the originals of figures 2*a*, *b*, *c* and *d* are referred to this species, in the explanation of the plate that of figure 2*a* is placed under Actinoceras crebriseptum, obviously on good grounds, yet indicating the difficulty that is encountered in differentiating the two species in the poorly preserved material of the Lorraine formation. Of the other three specimens, only the original of figure 2*d* is now extant, in the American Museum of Natural History. For this reason and because it much better agrees with Hall's description than the other two and evidently was his type, it should be considered as the holotype of the species. This specimen kindly loaned to us by Doctor Hovey, has afforded the following data, which are corroborated by other specimens:

The conch, an orthoceracone, is of medium size, having attained a size of 3–4 dm, very gradually expanding (at a rate of 7 mm in 100 mm), of subcircular section, the minor diameter being but one-tenth smaller than the major, due to a slightly flatter curve on the ventral (?) side. Living chamber probably very long. Camerae fairly closely arranged, numbering five in a distance equal to the major diameter of the conch, sutures straight transversal, depth of septa about equal to that of camerae. Siphuncle small, 2.5 mm wide at septal perforation, where conch is about 14 mm wide, slightly excentric toward the flattened side of conch, slightly nummuloidal, apparently without deposits.

Surface apparently smooth but furnished with very faint transversal and crowded fine longitudinal lines, only visible under a strong lense.

The typical lamellosum is found in the Pulaski formation, especially the calcareous sandstones and therefore often in the Lorraine drift blocks. In the Whetstone Gulf shales flattened casts of a cephalopod are common, which have lost all trace of the interior structure, but in dimension, rate of growth, spacing of sutures (about five in diameter of conch) exactly agree with P. lamellosum. The surface is in these shale specimens most exquisitely preserved and consists in the smaller ones of sharp intersecting transversal and longitudinal lines, in the larger ones of very sharp raised transversal lines.

The reference to Paractinoceras is based on the slender, but slightly nummuloidal character of the siphonal segments and apparent absence or very weak development of calcareous deposits within the siphuncle, but it must be admitted that the form is, in all its appearance, except the slight, interseptal expansions of the siphuncle, still a true Orthoceras. The funnel (see text figure 24) appears, however, to have been bent and crumpled as in the sub-order Cyrtochoanites, to which the Actinoceratidae belong.

The species has been cited from the Lorraine beds of Canada by Chapman, Nicholson, Ami, Foerste and lately by Parks and Fritz, owing to the inadequate original description, with more or less doubt.

Paractinoceras (?) **pusillum** nov.

Plate 16, figures 4–6

There occurs in the drift material of ferruginous calcareous sandstone from the upper Lorraine (Pulaski) a small form that in its general habitus resembles a young Paractinoceras lamellosum. It differs, however, from that fairly large species in attaining but a length of about 100 mm where the crowded septa below the living chamber indicate that the specimen had reached maturity. Its rate of growth is also more than double that of lamellosum.

The type is a small orthoceracone (77 mm long, incomplete at proximal end, 16 mm wide at aperture), growing at a rate of 18 mm in 100 mm. Its section is subelliptic, with but slight difference between the major and minor diameters (about 4:3). Living chamber moderately long, its width to its length as 3:5 (width in type 15.5 mm; length 24.5 mm). Aperture straight transverse. Camerae closely arranged, numbering five in the diameter of the conch and 2.5 mm apart in the neanic portion. Sutures straight transverse, depth of septa about equal to that of camerae. Siphuncle of medium size, 2 mm wide where the shale has a diameter of 15 mm; near center, slightly nummuloidal.

Family **Oncoceratidae** Hyatt

Genus **Oncoceras** Hall

Oncoceras pupaeforme nov.

Plate 16, figures 2 and 3; plate 19, figures 1–8

Description. Medium-sized, breviconic cyrtoceracone with considerable curvature, the arc of the outer margin having a height of 12.5 mm above a chord 55 mm long; very rapidly expanding, the dorsoventral width increasing a little more than 1.5 times as fast as the length, to near the living chamber which decreases in size to about two-thirds of its former dimension. Living chamber short, its length to its width (dorsoventral) about as 4:7, occupying not more than one-quarter of the conch; aperture wide open; apertural margin nearly straight, with a shallow hyponomic sinus on the outer side (exogastric). Cameras shallow, 2 mm deep in the ephebic part of the conch; the septa but little concave; their depth being not much greater than that of one chamber, rising toward the outer side of the conch. Siphuncle nummuloidal, 1 mm wide, subcentral. Surface furnished with fine growth-lines.

Measurements. Type (plate 19, figure 3); length (imperfect), 60 mm along outer curve, 50 mm median line, 38 mm along inner curve; width at proximal end 8.5 mm; greatest width 28 mm; width of aperture 23 mm.

The largest specimen observed (in United States National Museum) measures 35 mm at base of living chamber and 80 mm along outer margin from apex to living chamber.

Horizon and locality. Upper Utica shale at Holland Patent, N. Y.

Observations. Owing to the strong compression of the shells in the shale, there is some uncertainty as to the diameter of the conch.

A comparison of the specimens exhibiting the lateral side (as plate 19, figures 2 and 3) with such showing the ventral one (figure 4) leaves, however, no doubt that the conch was compressed in form, and the dorso-ventral diameter about one-sixth longer than the transversal diameter, and probably, as indicated by the more frequent longitudinal breaks the outer (ventral) side was rounder than the inner (dorsal) one. Figure 4 indicates that as in other Oncoceratidae the living chamber contracted most strongly in the transverse diameter.

Specimens 1, 2 and 6 represent, as shown by the last two closely arranged septa, fully mature or gerontic individuals and the curvature of the conchs shows that the contraction of the living chamber began only shortly before that stage was reached.

O. pupaeforme is, among its congeners, most similar to the Trenton form O. constrictum; readily distinguished, however, from the latter by its lesser curvature and the subcentral position of the siphuncle.

Among Cincinnatian fossils our species could be compared only with "Gomphoceras" cincinnatiense and G. faberi Miller (1884, p. 19) two Maysville (Corryville) forms that are probably congeneric with O. pupaeforme and similar in general habitus. At any rate it is very doubtful whether they belong to Gomphoceras which has a laterally contracted aperture with an extended hyponomic sinus; while the two species exhibit a generally contracted living chamber as in Oncoceras. They differ in having the siphuncle close to the convex side (ventral side Miller), while in O. pupaeforme it is situated subcentrally.

While the contraction of the living chamber is currently considered as a gerontic feature, it appears in the specimens here referred to O. pupaeforme both in larger and smaller individuals carried to such an extent (compare plate 19, figures 2 and 6) that if all belong to one species the individuals had reached maturity at very different sizes. There can be distinguished a group of large mature forms, represented by figure 3 and of small mature forms, represented by figure 2. It would, according to the common modes of procedure in distinguishing species in Paleontology, be proper to separate these two series into two different species or at least varieties. The failure, however, to find any other differences suggestive of specific separation, but that of relative size, and the improbability that different individuals of a species should reach maturity at such different sizes, lead to the inference that the two larger and smaller groups of individuals represent the two sexes of one species, an inference that is supported by the well-known difference in size between the two sexes of many recent cephalopods; the males usually being the smaller.

The two forms may hence be distinguished here as Oncoceras pupaeforme mas and O. pupaeforme femina.

Specimens as that respresented by plate 16, figure 2 which, although larger than the group of smaller forms with contracted apertures, retain the wide open aperture and uncontracted living chamber of the immature stages are here considered as such stages of the larger (female) (O. pupaeforme femina) individuals. Otherwise they would have to be separated as a third species, belonging to Cyrtoceras. They are, however, found not only associated at the same horizon with the other two forms, but in rate of growth, depth of camerae and curvature, they fully agree with the others.

This interesting subject has been discussed by the writer in a paper On Sex Distinction in Fossil Cephalopods (N. Y. State Mus. Bul. 227–28, 1919, p. 68–70).

Phylum **Arthropoda**

Subphylum **Branchiata**

Class **Crustacea**

Subclass **Trilobita**

Order **Hypoparia**

Family **Trinucleidae** Emmrich

Genus **Cryptolithus** Green

Cryptolithus bellulus (Ulrich)

Plate 21, figures 1–3

Cryptolithus bellulus occurs in both the Indian Ladder and Whetstone Gulf beds of New York. It was originally (1878, p. 99) described from the Cincinnati group of Covington, Ky. It has also been described by Ruedemann from the Indian Ladder beds in eastern New York, by Bassler (1919, p. 333) from the Eden division of the Martinsburgh shale of the neighborhood of McConnellsburg, Pa. and lately by Foerste (1924) from a number of localities in Quebec, and also from the Don Valley brickyard at Toronto and the Sheguiandah clay of Manitoulin island in Lake Huron. The form is therefore of wide distribution in northeastern North America in beds of Eden age. It is one of the commoner fossils of the Whetstone Gulf formation of New York.

Foerste (1924, p. 237) states its differences from other species as follows:

> Compared with other species, entire cephalon remarkably low and flat. Neither the glabella nor the fixed cheeks as strongly convex as in C. tesselatus, pitted brim flattish and almost horizontal in position. Pits forming the two outer rows of the brim conspicuously larger, tending to be arranged radially, with the posterior end of the glabella at the center of the radii. The pits of the inner rows alternate in position.

We may add that the prominent girder separating the two connected anterior rows from the posterior ones in C. tesselatus is entirely absent in C. bellulus, while, on the other hand, one of the differential characters mentioned by Ulrich is not any more valid. This refers to the absence of the long spines from the posterior angles of the shield.

The investigations of Cowper Reed, Foerste and others have since shown that the genal spines are extensions of the " girder " separating the first and second rows of punctures on the underside, and the preservation of the spines is thus dependent on that of the lower plate of the brim. They were therefore undoubtedly a steady feature of Cryptolithus.

A further species, Cryptolithus recurvus Ulrich (Bassler, 1925, p. 394) has been recognized in the Eden of Covington, Ky. and at Jordans Knob, Pa., and it may, according to Foerste (1924, p. 239), also occur in Quebec. It is principally distinguished by the great width and, as its name implies, the decided posterior recurvance of its border. Foerste (1924, p. 239) has also found it on the Nicolet river in Quebec and it will therefore be found probably in our Whetstone Gulf formation. As a matter of fact, one of the characters which is cited by Ulrich as distinguishing C. recurvus from all American species of the genus, namely the finely punctate and not reticulate marking of the glabella and lateral lobes is shown by our whole material of bellulus.

Cryptolithus lorrainensis nov.

Plate 21, figures 4–5

The species here referred to is generally known among students as Trinucleus concentricus (Eaton), this name having secured general adoption through its use in Hall's volume I of the Palaeontology of New York. The species was described at almost the same time (1832) by Green as Cryptolithus tesselatus and by Eaton as Nuttainia concentrica; Hall adopted the specific name proposed by his teacher and the generic term Trinucleus (Llwydd) Murchison then used in Murchison's Silurian System. Foerste (1910, p. 78 ff) has recently investigated the merits of these various specific and generic names and come to the conclusion that Cryptolithus tesselatus has the right of priority, a view corroborated by Raymond (1913, p. 4) and adopted by Bassler (1915, p. 295).

Bassler, presenting in his Bibliographic Index the most advanced taxonomic views that are extant in the literature gives Cryptolithus tesselatus a range from the Trenton to the Maysville and a geographic distribution from Canada and New York to Oklahoma, Kentucky and Virginia. It has also been recorded from the Middle Bala limestone of Shropshire, England (see Cowper Reed, 1912, p. 352). In New York this species is supposed to range from the basal Trenton (Glens Falls limestone) to the top of the Lorraine, save the last zone, (that of Pholadomorpha pholadiformis); Hall having already described it as a fossil occurring in both the Trenton limestone and "Hudson River shales" but "unknown in the intermediate Utica shale." Beecher has later (1895, p. 309) also described specimens, retaining the appendages, from the Utica (*rectius* Frankfort) shale at Rome (Six-mile creek section), while the present writer (1912) has recorded the presence of C. tesselatus in the shales of Trenton age in the Mowhawk and Hudson valleys (Canajoharie shale, Snake Hill shale, Schenectady beds), as well as in the Frankfort shale. Raymond (1916, p. 248) has then pointed to the fact that C. tesselatus is restricted to certain definite horizons in the Trenton, and is exceedingly abundant very near the base of the Trenton, in the Glens Falls limestone, occurring also in the lowest layers at Trenton falls, but not in the Trenton anywhere west of the Adirondacks, then again in the Utica at Rome and next in the Lorraine formation. Foerste (1914, p. 318) has suggested that it is scarcely likely that the Cryptolithus found in the Pulaski or upper Lorraine belongs to the same species, as Green's types which came from the shale at Waterford, belonging to the Snake Hill formation of lower Trenton age. He carefully described the Pulaski type (see below).

It is obvious that Hall had already attempted to separate the Trenton and Lorraine representatives of Cryptolithus. He states (1842, p. 255):

> The specimens from the slates of the Hudson River group are more flattened than those from the Trenton limestone. In a large number of specimens examined, there are four rows of punctures in front of the buckler, while a few have but three rows; on the other hand, those with four rows are rare in the Trenton limestone, while those with three rows are the prevailing form. This difference, however, can not be regarded as essential, for in a few instances there are five rows, and very frequently five or six rows on the maxillary margin, near the posterior termination of the buckler.

Ulrich (1878, p. 99) has already separated off as C. bellulus a small form apparently restricted in the west to the Economy horizon of the Eden beds and in New York to the Whetstone Gulf formation.

In the endeavor to elaborate the differences, if there are any, between the Trenton and Lorraine representatives of C. tesselatus, we have brought together large series of Trenton limestone specimens, mainly from the Glens Falls limestone, but also from higher beds (Boonville), and Lorraine material, as well as smaller series of Snake Hill, Canajoharie and Schenectady specimens. A general survey of these shows that Hall's suggestion of a difference in the development of the brim is absolutely true, when one compares specimens of equal stage of development, for we have blocks of Glens Falls limestone and lower Trenton from Trenton falls before us, entirely filled with carapaces, none of which shows more than three rows of pits in front of the glabella, while blocks of Lorraine shale, equally crowded with mature specimens of the same size show none with less than four rows of pits. This difference marks then a fully recognizable stage in the progressive development of the brim or fringe.

Hall's failure to recognize it as of specific value is obviously due to the fact that he counted the material from the eastern shales of Trenton age (Canajoharie, Snake Hill, Schenectady) with the Lorraine beds (" Hudson River beds ").

While we have not been able to find mature specimens in the Trenton limestone with four rows, we have specimens from Rowland Mills before us of the great width of 21 mm with but three rows of pits in front, the fourth not beginning till the middle of the " cheek."

As Green's type specimens came from the Trenton shales about Waterford, near the junction of the Mohawk and Hudson rivers, it is of vital importance for the differentiation of the species of Cryptolithus to establish the characters of the members of Cryptolithus in the Canajoharie and Snake Hill shales, which both are found near Waterford. Green himself has described his species as follows (1832, p. 73):

> Clypeo rotundato, fronte valde convexo, capite antice semi-circulari margine tesselato ornato.
>
> Outline of buckler hemispherical, the edge surrounded by a semicircular border of tesselated or rounded punctures, in three concentric rows in front — on each side near the posterior angle of the buckler, these rows of punctures are more numerous; the front is highly convex; is rounded before, and gradually tapers towards the abdomen. The cheeks form spherical triangles, and are entirely destitute of oculiferous tubercles or any other markings; their posterior angles project beyond the sides of the abdomen. Abdomen

and tail very much compressed, and composed of about ten articulations; costal arches of the lateral lobes grooved; tail attenuated. Whole length half an inch.

Green especially states the number of pits to be three, and while it is probable that his type specimen is not a mature one, it is on the other hand a fact that Lorraine specimens scarcely more than half the size of Green's type have four rows of pits in front and that larger Trenton specimens than Green's have but three rows of pits. Ulrich's minute C. bellulus has also four rows.

Green's statement is corroborated by our material from the shales of Trenton age in the lower Mohawk and Hudson valleys (Canajoharie, Snake Hill and Schenectady beds). Unfortunately the specimens we have obtained in these formations are but small and in part fragmentary, or disfigured through the intense folding of the shales, and hence not as conclusive as would be desirable. We have, however, at least six carapaces of mature specimens from the Snake Hill shale, which distinctly show the rows of pits. Of these three have but three rows, in two the fourth row reaches the glabella entirely or nearly, the pits being, however, so small and so crowded against those of the third row as to be indistinct, while in the Lorraine they are but little less developed than those of the outer rows. The sixth, a specimen of the very unusually large width of 21 mm, has four distinct rows. Of four carapaces from the Canajoharie shale three have undoubtedly but three rows; the fourth may possibly have had a small fourth row. The material of Cryptolithus from the Schenectady beds is too fragmentary to be of any use in this case.

Green's and our material show at least one fact, namely that the Cryptolithus from the "Hudson River shales" is distinct from the Lorraine Cryptolithus in the matter of the rows of pits and that in this character it better agrees with the Trenton material. We shall presently see that there are still other characters to corroborate this correlation.

We have no knowledge of the characters of the carapace of the Utica Cryptolithus, since we have never yet found a Cryptolithus in the Utica shale. The supposed Utica shale at Six-mile creek near Rome is the Frankfort shale and contains C. bellulus.

The brims of the Trenton and Lorraine forms of Cryptolithus exhibit still further differences. There is a tendency to a radial arrangement of the corresponding pits of the two outer rows and to their union in depressed sulci; such as is seen in the British Trinucleus seticornis (Hisinger); [1] this tendency has been followed farther in the Lorraine material if not in so far as the further outward extension of the radial arrangement is concerned, then in the development of the deeper sulci, although it must be conceded that much of this latter feature may be due to the preservation of the interior caste of the brims of the Lorraine material only; for while the Trenton specimens when fully preserved show no trace of this union of two pits in one sulcus, the interior cast of the cavity of the brims shows the outer pits united, because they were surrounded by a thicker rim. The differences of preservation between the uncompressed specimens from the Trenton limestone, preserving the test, and the flattened specimens from the Lorraine shale, in which all trace of the test has disappeared, are apt to suggest imaginary differences of structure and also hinder a conclusive comparison of the outlines of the carapaces, but there can be no doubt that the carapaces of the Lorraine material are more rounded in outline than those of the Trenton that are rather squarish appearing in front, and what is more material, they are relatively longer, their length to their width being as 1:2, while in the Trenton material it is as 1:2.5. Actual measurements of largest carapaces of the former are 11:22, of the latter 8:20, 8:21 in Glens Falls limestone specimens, and 8:20 in the largest Snake Hill shale specimen. This difference is not attributable to the preservation but is in part, at least, correlative to and induced by the greater width of the brim and it is important that in this feature the Snake Hill and Canajoharie material fully agrees with that from the Glens Falls limestone.

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[1] See Cowper Reed, 1912, plate 19, figure 5.

The genal spines, as well as the smaller spine of the occipital ring are present in both forms, and their absence or presence in specimens is merely a matter of preservation.

It is very difficult to compare the pygidia because the Trenton limestone, as already remarked by Hall, does not furnish these obviously thin, delicate plates, however common the carapaces may be. The pygidia from the Snake Hill beds when compared with those from the Lorraine are more distinctly triangular, the posterior margin being nearly straight or at least not so well rounded as that of the Lorraine specimens. A still more distinct difference is seen in the greater width and less tapering outline of the axis of the pygidium in the Snake Hill types.

It is on these differences that we have separated the Lorraine species as C. lorrainensis from the Cryptolithus tesselatus Green of the Trenton.

We can do no better than to copy here Foerste's description (1914, p. 318) of the Lorraine form:

The following is a description of a series of specimens occuring in a single block of fine-grained Lorraine rock from which most of the lime had been dissolved, leaving the specimens in the form of casts of the upper and lower surfaces of the cephalon.

Glabella obovate, tumid in front, becoming lower and narrower posteriorly; at the posterior margin of the cephalon its width is equal to half, or slightly less than half the width of the glabella anteriorly. Here the posterior end of the glabella is crossed by the nuchal furrow in a direction convex to the rear, posterior to which the glabella extends with a rounded V-shaped outline, projecting behind the posterior margin of the cephalon a distance about equal to the width of the glabella at this margin. Posteriorly, this nuchal V-shaped segment of the glabella terminates in a sharp narrow spine about 2 mm in length, always present, but generally overlooked. On each side of the posterior part of the glabella, in the nuchal groove, and also a very short distance anteriorly, there is a small depression or pit which is the only evidence of segmentation shown by the glabella. The glabella rises an amount equal to almost half its width above the general convexity of the cheeks. The latter are moderately convex over most of their surface, becoming slightly tumid only laterally, where they adjoin the pitted border. A narrow groove separates the cheeks from the equally narrow raised posterior border of the cephalon. For two-thirds the width of the cheek, the posterior border of the cephalon is directly at right angles to the longitudinal axis of the cephalon, and then curves diagonally backward toward the genal spines. The pitted area extends, from the pitted lateral border, around the postero-lateral part of the cheeks almost as far as the point at which the posterior border of the cephalon begins to curve diagonally backward. Anterior to the glabella there are four concentric rows of pits, which remain distinct as far as a point opposite the posterior margin of the free cheeks. A fifth row is intercalated between the third and fourth rows from the front, at a point almost directly in front of the middle of the cheeks, and a sixth row is intercalated between the fourth row and the cheeks, a little anterior to the mid-length of the latter.

The first two rows of pits, counting from the anterior margin, may be distinguished from the remainder by the fact that for about two-thirds of the width of the cephalon the pits of these two rows are vertically in front of each other and the line of separation between the members of each pair depressed, so that here the pitted border consists of a lateral succession of pairs of pits sunk into a common depression. Specimens differ widely as to the degree in which this appearance of a lateral succession of pairs finds expression. Toward the genal angles, the pits of these first two rows become alternate. The pits on the lower surface of the cephalon correspond in position to those on the upper surface, and between the first and second rows on this lower surface, there is a raised ridge which may be traced backward into the genal spines. In well-preserved specimens the latter extend straight backward, continuing in the direction of the lateral border of the cephalon. Specimens differ greatly in their relative width and length, probably due to different degrees of depression of the convex cephalon, but the best preserved specimens show a ratio of 44 per cent between the length of the cephalon, as far back as its straight posterior border, and its width.

The specimens here described were obtained from a block in the upper part of the gulf west of Turin, near the upper part of the road ascending southwestward toward a school house on the pike.

It may be added that some well-preserved specimens show three pits or depressions in the nuchal groove, the same as C. tesselatus. The surface of the glabella is entirely smooth in most specimens, in some, however, finely pitted.

The tubercle on the glabella considered by the writer as a median or parietal eye, and the supposed suture lines on the frontal part of the glabella as well as on the cheeks, have been described before by him (1916, p. 127, 144). Of the figures given there of Cryptolithus on plate 35, figure 6 represents a Cryptolithus lorrainensis, the others C. tesselatus. The difference between the brims of the two species is well shown in figures 6 and 7.

The glabella grows with advancing age relatively larger than the carapace and becomes bulbous in the gerontic stage while in the earliest stages it is but little protruding and elongate elliptic. This is probably connected with the feeding habits of Cryptolithus, which gorged itself with mud, for as Beecher (1895, p. 311) has pointed out, many specimens have been found preserving the cast of the alimentary canal indicating such a habit. Jaekel (1901) has suggested that the bulging glabellar lobe in Cryptolithus and similar mud-feeding forms was necessary to provide room for the capacious stomach and this feature is overemphasized in the gerontic specimens. In the carapace figured here, which possesses the large width of 29 mm and a length of 12 mm, the glabella has encroached to such an extent upon the brim that the number of rows is again reduced to three in front of the glabella, although all the adolescent and mature stages, which fill the rock possess four; and the third row is distinctly pressed forward.

The test is very rarely preserved in the Lorraine material and hence there is generally seen only a cast of the interior. Where this test is preserved, a median row of strong mucros is seen on the axial lobe.

Foerste (1924, p. 238) has also pointed out the differences between C. lorrainensis and C. bellulus, as follows:

At the Rafinesquina pulaskiensis zone, west of the bridge 1 mile east of Pulaski, N. Y., specimens of Cryptolithus occur which resemble C. bellulus in the long, acicular spine terminating the nuchal segment posterior to the glabella, and in the number and arrangement of the pits on the broad brim. The cephalon, however, is relatively longer, narrower and more convex, and the posterior border of the cephalon curves more strongly backward toward the postero-lateral angles. Two pits occur on each side of the cast of the lower surface of the posterior end of the median lobe: one at the anterior margin of the distinct nuchal furrow, a short distance above the level of the dorsal furrow; the other pit at the posterior margin of the nuchal furrow. These pits are remnants of former segmentation of the glabella. Immediately anterior to the nuchal furrow the posterior margin of the glabella is slightly ridged transversely.

We may add that both C. bellulus and lorrainensis differ from the other American congeners in the pitted surface, instead of a reticulated one, and in the absence of the dividing girder between the first two rows of paired pores and posterior rows of alternating pores of the brim. C. lorrainensis is, however, distinctly larger and the cephalon longer and more convex both in the glabella and in the cheeks, characters in which the species again approaches C. tesselatus.

The form figured by Cowper Reed from the Middle Bala of England, as Trinucleus concentricus (1912, plate 18, figure 4; 1914, plate 29, figures 3, 3*a*) is probably nearer related to C. lorrainensis.

While in the Trenton limestone one only finds the carapaces crowded in the rock, getting the impression that these are the remains of the moulting of the trilobites, one finds in the Lorraine entire specimens, for the most part spread out flat, crowding the rock. A slab in the State Museum, 5 by 7 inches and containing on one side the tests of about sixty-six specimens has been reproduced in plate 4 of part 1 (Bull. 258). These are not spread out on a bedding plane, but fill the rock in such a way as to give the impression that groveling in the mud, they were buried where they lived. Some are enrolled, (see plate 21, figure 6) in which case the pygidium snugly fits the underside of the carapace, leaving the brim free. It is seen that in the enrolled condition, the two genal spines together with the posterior spine of the occipital ring served as a complete protection for the most endangered part of the trilobite, which is the segmented thorax.

Cryptolithus goldfussi (Barrande) is a European Ordovician form that is extremely similar to C. lorrainensis in general outline and may well be a vicarious form of the eastern Atlantic basin to our Lorraine form that probably originated in the western Atlantic. The two similar species still differ in the number of rows of pits that reach the front of the glabella, this number rising in the European species to five and six.

Order **Opisthoparia**

Family **Olenidae** Burmeister

Genus **Triarthrus** Green

Triarthus becki Green, emend. Ruedemann

Plate 21, figures 10–12

"Triarthrus becki" is one of the widest known of trilobites because it is considered an important index fossil of the Utica shale, and especially because it has furnished the material for the classic investigations of the appendages of trilobites by Beecher and Walcott. It is, therefore, with deep regret that I find myself constrained by facts that have been discovered to restrict Green's species to a form that occurs below the Utica shale and is specifically different from the Utica species.

Green's type material of his Triarthrus becki (Green, 1832, p. 87) came, according to a label with an original cast (United States National Museum no. 4966) from the " Cahoose Falls, N. Y., and Green states: " This fossil occurs in black shaly limestone, on the canal near Cohoes falls, in the State of New York, and at a number of other places in that State." While it appears from this statement that Green, as his successors, included the Utica form in his species, the fact remains that his description and figure are based on the type from the Cohoes falls. This type now comes from the Snake Hill formation, which is Trenton in age, and further it differs specifically from the Utica and Frankfort species. Before we were aware of this fact, we had already recognized this difference between the Lake Champlain material of Triarthrus and the Utica form and described the former as a new species. Our new name is now a synonym of becki and the Utica species instead requires a new name.

Perusal of the early literature on our trilobites brings out that there have already various names been proposed for this species of the Utica shale and that the synonymy is quite involved. First, Harlan (1835, p. 263) 3 years after Green's proposal of the name Triarthrus rejected that name on the ground that Green had wrongly described the cranidium as the pygidium and that the name was therefore a misnomer. At the same time he believed he saw certain differences between Green's species and the form from Utica on the strength of which he proposed the species Paradoxides triarthrus and Paradoxides arcuatus. The former is supposed to have been relatively broader but is concededly based upon a distorted specimen, the second species arcuatus is stated to differ from becki "in the greater proportional size and form of the lateral lobes of the buckler." As a matter of fact, the fixed cheeks of the Utica species are not at all larger than those of T. becki but smaller and more abruptly contracted forward (see below). It would thus seem that neither name has any title to recognition.

Three years later Hall, (Hall, 1838, p. 139) urged by Professor Dana in a correspondence which we have had an opportunity to see, took up the problem of the different appearances of the Utica trilobite and rejecting Harlan's species distinguished Paradoxides becki (Green) and Paradoxides eatoni Hall. It is obvious from Hall's descriptions and figures that he had correctly recognized the specific differences between the eastern Trenton and the Utica form. He withdrew, however, his new species 5 years later (Hall, 1847, p. 237), uniting both, and also Emmons' Atops trilineatus under "Calymene Beckii." This proceeding of rejecting his own species, very strange in Hall, is obviously due to the Taconic controversy that meanwhile had sprung up, and under whose influence Hall had become anxious to minimize the faunistic differences between the shale at Utica and that in the lower Mohawk and Hudson valleys.

Now that not only the morphologic differences but also those of stratigraphic position between the two forms are apparent, it becomes necessary to give them recognition by separate specific names. The name "Triarthrus becki" must then become restricted to that form which corresponds with Green's original description and figure, and Hall's name "eatoni" becomes again available for the Utica species.

Neither Green's diagnosis[1] nor his remarks on the species fix the differential characters; it is his fairly accurate figure, his cast and the locality (Cohoes falls) given by him, that assure the species its standing. Hall, (1838, p. 142), when discriminating between T. becki and T. eatoni, described the cranidium as "bounded in front and laterally, by a nearly uniform curve scarcely exceeding a semicircle and distinctly convex; while T. eatoni has the cranidium convexly curved on the front margin, with a concave curvature laterally, and being nearly flat." The fixed cheeks are described as gradually widening posteriorly in the former species and as broadest posteriorly in T. eatoni, but abruptly diminishing in breadth opposite the center of the glabella. Finally the glabella is described in T. becki as somewhat broader than long, "and in T. eatoni as somewhat longer than broad."

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[1] Cauda subrotunda, bipunctata; articulis abdominis tribus, absque lobis ateralibus consuetis, sed lobo arcuato utrinque apposito.

All of these differences, although later attributed by Hall to states of preservation, have been found by the writer to be true and reliable.

Hall in 1838 cites T. becki as occurring "abundantly in graywacke slate at the Cold Spring on the Erie canal, 8 miles east of Little Falls," adding: "This slate lies upon the lower transition limestone, of that part of the State." This locality is in the Canajoharie shale (upper or Dolgeville shale division.)

From a close comparison of specimens of Triarthrus becki with T. eatoni it can be claimed that while in the former the glabella is wider than long, it is in becki from one-sixth to one-tenth longer than wide. The appended table gives a number of measurements showing this difference.

T. eatoni from Holland Patent	T. becki
l:w (in mm)	l:w
9:8	6.4:7 (Green's specimen)
9.3:8	6.4:7.7 (Green's specimen)
9.5:8.7 (very little compressed)	7:7 (several specimens from Stony Point)
10:9 (several specimens)	7:7.5 Stony Point
10.5:9.5	7.7:7.7 (one of Green's specimens)
10.7:9.7	
11.5:10	7.3:8 (Cohoes)
12:10	8:8.5 (Cohoes, Stony Point)
12.5:11.5	8.5:9
	8.5:9.5 (Stony Point)
	9:9.5 (Stony Point)

The frontal lobe of the glabella is distinctly shorter in T. becki than in T. eatoni. The dorsal furrow is not parallel as in T. eatoni but distinctly diverging forward, and the outline of the glabella as a result less subrectangular but more rounded, especially at the antero-lateral angles and in front.

The glabellar furrows are disposed slightly more horizontally, their angle with the horizontal furrow amounting to but 20 degrees on an average direction, while that of T. eatoni is near 30 degrees.

Another difference rests in the fixed cheeks which are larger, the contraction not taking place opposite the second pair of glabellar furrows as in the eatoni, but opposite the first pair. As a corollary the palpebral lobe is distinctly shorter and the eyes were probably smaller and even placed farther forward.

The mucros upon the axis of the thorax are thicker and a little longer, being slightly overlapping.

Corresponding to the relatively broader glabella, and also broader head, the body was also relatively broader than in T. eatoni. We have, however, not enough entire specimens of T. becki to make a safe estimate of this difference.

The surface is furnished with fine, fairly evenly distributed tubercles, too fine to be seen with the naked eye.

Horizon and localities. T. becki appears to range through the middle and upper Trenton shales in eastern New York. Its original locality is the Snake Hill shale at Cohoes, N. Y., but it enters the Mohawk valley with the Canajoharie shale, thereby reaching as far west as Cold Spring (Mindenville) east of Little Falls; it likewise occurs in the Schenectady beds and it passes with the Canajoharie and other Trenton shales through the Champlain valley, whence we have seen typical material from various localities, among them dark gray calcareous shale on Isle La Motte (Cumberland Head shale, United States National Museum no. 34538) and especially the shale at Rouses Point. In the whole the species is common only in the upper Trenton members of the shale and in the shaly, more or less argillaceous facies of the Trenton, exposed in the lower Mohawk and Hudson valleys and in the Champlain Basin.

Material collected by Doctor Ulrich in the basal few feet of Martinsburg shale in a small railroad cut 7½ miles south of Chambersburg, Pa., proves the presence of this species also in the lowest division (Sinuites bed) of the Martinsburg shale. Bassler (1919, p. 342) cites the species from still other out-crops of the Martinsburg shale in Pennsylvania and Maryland. It is then probable that this species extends through the whole length of the Trenton shales in eastern New York and the extension of the shale belt through New Jersey to Pennsylvania and Maryland.

Remarks. T. becki is distinguished from the variety maccasteyensis, described by Twenhofel (1914, p. 34) from the Macasty (Collingwood) black shale of Anticosti island, by the broad glabella and the different course of the facial suture in front, the suture diverging from the axis in maccasteyensis.

In the size of the fixed cheeks and the slight forward expansion of the glabella the Swedish T. becki var. humilis Hadding, (Hadding, 1913, p. 69) is identical with our form, although differing in the greater relative length of the glabella. The Swedish form, which occurs in the lower Dicellograptus shale and below the zone of Nemagraptus gracilis, in the zone with " Climacograptus putillus " is older than ours. In Great Britain Cowper Reed (1903, p. 28) has described an unnamed variety of Triarthrus becki which shows similar characters. It is therefore legitimate to conclude that T. becki shows closer relationship to the North Atlantic forms as they appear in Europe, than to the more southern form, exemplified by the T. eatoni.

Triarthrus eatoni (Hall) Ruedemann emend.

Plate 21, figures 7–9

Original description (Hall, 1838, p. 142).

" Paradoxides Eatoni."

Buckler convexly curved on the front margin, with a concave curvature laterally; nearly flat; lateral lobes broader posteriorly, greatest width about one half the breadth of the middle lobe; abruptly diminishing in breadth and much less than half their greatest breadth opposite the centre of the middle lobe; middle lobe somewhat longer than broad, nearly flat; sulci distinct, with the intermediate portions scarcely convex.

This species is abundant in the graywacke slate in Turin, Utica, Fort Plain and elsewhere in the State of New York.

It has again, as Calymene beckii been fully described and figured by Hall in Palaeontology of New York, volume 1, p. 237, plates 64 and 66.

We have already, under the heading T. becki, very fully pointed out the differences between this, the Utica species and T. becki, the characteristic Triarthrus of the Trenton shales of eastern New York. Suffice it to state that it is principally characterized by the more elongate shape of the glabella, the more oblique direction of the glabellar furrows, the subparallel direction of the dorsal furrows, and the more squarish frontal outline of the glabella, and by the more abrupt and more posteriorly situated contraction of the fixed cheeks. As a result of this direction of the suture the eyes in T. becki are placed farther forward and more outward than in T. eatoni[1].

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[1] Doctor Foerste has meanwhile (1924, p. 239–40), using the author's manuscript, given short and precise definitions of the two species in question.

T. eatoni is the common Triarthrus of the Utica shale and it has become famous, also from material found in this State near Rome, by the preservation of the appendages which were elaborately described by Beecher (American Journal of Science 1894, 1896, American Geologist 1894, 1895) and Walcott (1918).

The species appears first as a rare fossil in the Trenton limestone at Middleville, etc., but does not attain its largest size and maximum development until the Utica age, where it grows to a length of 25 to 40 mm or more and is the dominant fossil. Specimens of this very large size were found about Oxtungo creek and also in the thinned northern edge of the Utica along Mill creek near Turin, N. Y. In the Atwater Creek shale, for instance at the mouth of the Lorraine Gulf it is still represented by relatively large specimens.

While Hall had recognized that the species entered from the Utica into the "Hudson River shale," Emmons used it as his guide fossil in drawing the boundary line between the Utica and Lorraine, which led him to a wrong correlation since Triarthrus eatoni far outlived the Utica fauna. We have found it to range throughout the first zone (Economy) of the Whetstone Gulf formation; and in the Lorraine and other sections in northern New York it also passes through the lower half of zone II (Southgate division), but probably it reached the end of that division (see Mill creek section).

The remarkable feature of the Whetstone gulf or Eden specimens[1] is their very small size, though they are present in considerable number. The average length of the cranidia is but 3 mm while that of the fully grown Utica forms is 13 mm. It is true there were also found a few medium-sized cranidia (one 8 mm long), indicating that Tr. becki was still able to attain a subnormal size, but the great majority of specimens found are so small as to indicate a serious reduction in the individual size. We therefore considered it possible that these small individuals would represent a gerontic mutation, but careful comparison with Utica specimens of equal size did not furnish any evidence that they attained mature characters earlier or while still of smaller size than the Utica specimens. Moreover, while the great majority of the Lorraine specimens are small, a lower Lorraine bed in Totman gulf near Lorraine, 180 feet above the base (United States National Museum no. 23598) has afforded a specimen of the gigantic size of 45 mm, in no wise differing from the Utica representatives in its characters.

The "Triarthrus becki" of the Canadian Gloucester shale is a true eatoni while that of the Collingwood shale (at

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[1] See T. huguiensis Foerste, p. 123.

Collingwood) represents a mutation that still shows some approach to the earlier becki in the subequal length and width of the glabella and the course of the facial suture.

Triarthrus spinosus Billings

Plate 21, figures 13–16

We have before us four specimens of Triarthrus spinosus from the upper Utica shale at Holland Patent, N. Y. Billings' types came from the Utica shale in the townships of Gloucester, County of Carleton, Ontario. He describes the species as follows (1857, p. 340):

> This interesting little trilobite is principally distinguished from T. beckii by its spines. One of these springs from the center of the neck-segment and extends backwards to the third or fourth segment of the body; a second proceeds from the center of the eighth segment of the axis of the thorax, and projects back beyond the apex of the pygidium. Two others from the posterior angles of the head extend as far as the points of the seventh or eighth pair of pleurae.
>
> The spines are all slender, apparently cylindrical, and about one-fifth of a line in diameter.
>
> The species is destitute of the short spines of T. beckii; and in none of the specimens have I been able to detect more than thirteen segments in the thorax, and four or five in the pygidium, which is remarkably like that of a small specimen of Calymmene blumenbachii. In a well preserved specimen of T. beckii, in the museum, there are distinctly fifteen segments in the thorax and five in the axis of the pygidium so that if these two species be congeneric, the number of articulations in the genus must be of variable character.

None of our specimens is complete, but three retain the head and the thorax as far as the dorsal spine, and one a detached pygidium. From these the following notes have been taken.

The glabella is squarish in outline like that of T. becki, but the glabellar furrows are not so distinctly flexed in the middle, but rather straight and uniformly bent obliquely backward. The eyes are farther forward and nearer to the glabella than in T. becki, the anterior portion of the suture-line is therefore nearer to the glabella and sub-parallel to it, the posterior portion swings out more boldly and convex toward the postero-lateral angle and the area of the fixed cheeks is relatively larger. The nuchal spine in our specimens reaches as far as the sixth or eighth thoracic segment. It bears a small mucro on its base. The free cheeks which are as in the congener, bear the remarkable lateral spines, which do not proceed from the genal angles but from a point about one-third the length of the head forward of the angle. They are curved outward at the base and slightly inward more posteriorly. The thoracic spine attached to the eighth segment is wonderfully slender and straight (see plate 21, figure 16) and reached a length greater than that of the animal. All the spines were cylindric and hollow. Some of the pleurae may also have been prolonged into downward and backward curving flat spines. This is at least suggested by two such spines apparently attached to a fragment of a pleura and lying partly below the specimen reproduced in figure 14.

A large series of specimens in the United States National Museum, however, from the neighborhood of Ottawa contains individuals with more than three thoracic spines. One, partly enrolled and seen in lateral view, exhibits one straight, needlelike spine on the eighth segment, one 3 times longer and heavier, on the next and a third one that again is shorter on the tenth thoracic segment. Also the following three segments show traces of basal portions of spines, especially the last one, so that it seems that all axial lobes of the thoracic segments from the eighth backward bore median spines. This inference is supported by another individual in which the eleventh segment bears a distinct spine reaching beyond the pygidium and also the twelfth retains a fragment of one, preserved mostly as an impression. In another specimen the spine on the eighth and a much larger one on the ninth segment are seen; and several individuals show three or more spines upon the posterior portion of the thorax. It therefore is reasonably certain that T. spinosus has spines on most or all of the thoracic segments posteriorly of the seventh segment. There have, however, no traces of spinose prolongations of the pleurae been seen.

There is, moreover, in the United States National Museum, one specimen from Gloucester in Ontario, which finely preserves a cast of the exterior of the thorax and this is seen to be densely covered with fine lines, which under the lens appear as impressions of bristles, or very delicate spines, but were directed backward and slightly diverged outward along the middle line of the thorax.

The entire test is covered with minute tubercles, which are especially distinct or a little coarser on the middle lobe of the thorax where they are arranged in indistinct longitudinal lines. They are also seen on the spines.

T. spinosus is intensely interesting in at least two regards, namely, as an index fossil and as exhibiting distinct reversion.

It appears from Doctor Raymond's latest publication (1916, p· 255) that T. spinosus is one of the index fossils of the development of the Utica as seen in Ontario, to which he has given the name of Gloucester formation. The bearing of the occurrence of T. spinosus at Holland Patent on the correlation of the Gloucester black shale with the New York Utica has been discussed in part I.

Of more general interest are the characters of T. spinosus indicating reversion. These are the placing of the lateral spines forward on the free cheeks instead at the genal angles and the long spines at the base of the head and the middle of the thorax. The lateral cheek and the median thoracic spines are characters found in Cambrian ancestors of the Ordovician trilobites, but not among the latter. The median spine of the occipital ring is likewise a character very common among the Cambrian trilobites but very rare among the Ordovician forms, where it is best seen among such archaic types as Trinucleus, Ampyx, Telephus, etc. The reappearance of these archaic characters just before the disappearance of the genus furnishes interesting evidence of the revival of latent characters, under the stress of apparently unfavorable exterior conditions. It is thus a case of ancestral repetition appearing, however, not only temporarily, in the earlier ontogenetic states but continuing into the mature stages and thus assuming the forms of a true reversion to ancestral characters. This and similar cases of reversion in the trilobites have been discussed by the writer in New York State Museum Bulletin 227–28, 1919, p. 70–78 in an article On Some Cases of Reversion in Trilobites.

Triarthrus huguiensis Foerste

Plate 20, figures 5 and 6

Foerste (1924, p. 241) has distinguished a small late mutation of Triarthrus eatoni that he found in the Cryptolithus zone of the Lorraine of Quebec as huguiensis. His diagnosis of the forms is as follows:

> Cranidia usually not exceeding 5 or 6 mm in length. Nuchal and glabellar grooves as in Triarthus eatoni, but more sharply incised, at least on casts of the lower surface. Cranidia more convex. The chief differences are presented by the facial sutures. Palpebral lobes more strongly defined and extending backward to a point half-way between the posterior pair of glabellar grooves and the nuchal groove; they diverge less posteriorly from the dorsal groove of the cranidium. Posterior to the palpebral lobes the fixed cheeks appear narrower, equalling less than half the width

of the glabella instead of exceeding half the width as in typical T. eatoni. There is a minute granule along the median line of the nuchal segment.

We have observed the same small form of Triarthrus in the lower part of the Whetstone Gulf formation of New York, where at some horizons, as at station 2 of the Mill creek section (see part 1, Bulletin 258, p. 99) it is so common that its (fragmentary) remains entirely cover the surfaces of some strata. Considering the differences as of but mutational value, we have not separated it in part 1 from T. eatoni. It was this small form of Triarthrus which Emmons observed in the lower shales of the Lorraine formation and which led him to unite these shales with the Utica.

Family **Asaphidae** Burmeister

Genus **Ogygites** Tromelin and Lebesconte

Ogygites latimarginata Hall and

Ogygites canadensis (Chapman)

Hall (1847, p. 253) described and figured as Asaphus (?) latimarginata two pygidia among the fossils of the "Utica and Hudson River groups." The specimens were received from Doctor T. B. Crawe and Doctor Hall states as to the locality:

> This species has been seen only in a single fragment of slate, from near Watertown. I should not have ventured to figure it in this place, since there is some little doubt as to its precise locality; but that the fragment contains one or two other peculiar fossils, known only in the slate of this period.

The specimens were later sold with Hall's collection to the American Museum of Natural History. Whitfield and Hovey (1898, p. 66) question their coming from Watertown, adding: "Locality, more probably Collingwood, Canada," and Bassler (1915, p. 77) makes the observation: "Possibly the same as Ogygites canadensis (Chapman)."

Through the kindness of Doctor Hovey the specimens have been loaned to us for examination. Comparison with Collingwood material leaves no doubt that the pygidia indeed belong to Ogygites canadensis. It would then seem that the suggestion of Whitfield and Hovey might be true, if it were not for the fact that there is no reason why the Collingwood shale should not reach the neighborhood of Watertown, and this trilobite occur there.

The shale in which the two specimens are preserved is a fissile black, brown-weathering shale, such as occurs at Watertown in intercalation with the uppermost Trenton limestone. Moreover, the two little slabs contain besides Bythocypris cylindrica (Hall) and Primitiella cf. ulrichi, (James) numerous specimens of Ctenodonta pulchella (Hall); the specimens exhibiting beautifully the hinge-teeth. This species has, however, been described by Hall from "the black slate near Watertown" and it is also cited by Ami (1892, p. 24 ff.), together with Primitiella ulrichi, as a constant associate of Ogygites canadensis. We have not found it anywhere in the black shales of the true Utica, Deer River or Atwater Creek or lower Whetstone Gulf shales; it is therefore peculiar to the Collingwood shale in Canada, and also to the transitional shale at the top of the Trenton limestone at Watertown. Bassler, therefore, obviously on information from Doctor Ulrich, cites this Ctenodonta pulchella as a Trenton species.

The inference from these facts, however, is that the Ogygites quite probably occurs at Watertown at the top of the Trenton, where in association with Ctenodonta pulchella it marks the horizon of the Collingwood shale.

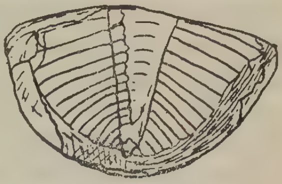
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Figure 26 Ogygites latimarginatus (Hall). Gelatine tracing of Hall's type. Natural size.

If Hall's types of Asaphus latimarginata actually came from Watertown, his species though based only on pygidia, is valid and will take precedence over Asaphus canadensis proposed 9 years later by Chapman. Chapman's species was originally also based on a pygidium only (1856, p. 482) and as sole character distinguishing it from Asaphus platycephalus (Isotelus gigas) he cited the grooved axis and distinct pleurae of the pygidium, which identical characters are very well shown in Hall's drawing and emphasized in his description. Furthermore, Hall claimed that Chapman's species is identical with his A. latimarginata (see Chapman, 1858, vol. 2, p. 47, 1858; vol. 3, p. 230) and Chapman (1858, p. 230) asserted, in return. "I should state, with regard to the figures of Professor Hall, alluded to above, that it is impossible to determine whether our species be identical or not with these."

It is true that the drawing of the smaller specimen, which is the type of O. latimarginatus, is less perfect than the specimen, at the antero-lateral angle, which is fully preserved, but it is nevertheless fully sufficient to show the characters of the pygidium of the form in question; and in the face of this fact, Hall's positive claim of the priority of his species and the further fact, that Hall's type is still accessible, there is no valid ground to retain the name "canadensis" for this species.

Genus **Homotelus** Raymond

Homotelus stegops (Green)

Plate 20, figure 4; plate 22, figures 1–9

Homotelus stegops was described as Isotelus stegops in 1832 by Green in his Monograph of North American trilobites (p. 71) from specimens coming from the "clay slate" at Newport, Ky. It is currently considered a synonym of I. gigas, but according to information from Doctor Ulrich, who has for some time been engaged on a revision of the Asaphidae, H. stegops is a valid species of the Eden and its presence was pointed out by him in our lower Lorraine collections from Wood creek, etc.

The original description of the species is:

> Clypeo antice, caudaque postice attenuatis, cuta coreacea punctis minimis.
>
> The head of this species is nearly in the form of a spherical triangle; its anterior edge is vertically flattened all round, but does not produce a narrow raised rim, such as is described by Doctor Dekay, to belong to the I. gigas. The eyes are prominent, and rather nearer the lateral edge of the buckler, than to its posterior border. The shell of the buckler forms a remarkable projection over the top of each oculiferous tubercle, something like an eyelid. Continuous with the edge of this cuticular projection, there is a curved linear depression, which terminates on both sides, at the edge of the buckler. This kind of suture, though remarkably developed in this species, is not peculiar to it, being more or less distinct in most of the Isoteli. The articulations of the abdomen are lost; there can be little doubt, however, that they were eight in number. The tail is subtriangular, and less in magnitude than the buckler.

This description was accompanied by no figures but two casts (nos. 26, 27).

The original description would hardly suffice to diagnose this species, but the casts which are found in several museums (as in the National Museum) and the locality given will afford a sufficient basis for the determination of its characters. This latter task will best be left to the acknowledged leader in the Ordovician paleontology of North America, and we will restrict ourselves here to giving figures, ranges and some notes of New York occurrences.

Homotelus stegops, according to Bassler (1919, p. 343) resembles most closely Isotelus maximus Locke, but "has the eye farther forward, smaller spines, and the flattened border especially of the pygidium, less distinct."

The species is referred to Homotelus Raymond by Foerste (1924, p. 243) because it lacks the strongly defined marginal depression of the pygidium in common with that new genus. It would seem from our material (see plate 22, figures 4 and 5) that the very young individuals still possessed the flattened border.

A carapace of an early growth stage, with a large median eye tubercle is seen in figure 1. Corresponding pygidia are reproduced in figures 4 and 8. These retain the ribs in the frontal portion of the pygidium and the annulations of the axial lobe. They are in general outline and sculpture, as well as the retention of the flat rim, undistinguishable from that of Proetus spurlocki Meek, an Eden species of the neighborhood of Cincinnati. Raymond, who has refigured the minute type of the species (1914, plate 1, figure 3) has pointed out that it undoubtedly is an early growth stage of Isotelus, probably of I. maximus Locke, and Bassler (1915, p. 1039) agrees with him. Our corresponding growth-stages of I. stegops, which on one hand lead to the smooth adolescent and mature pygidia of that species, connect these on the other hand with the fully ribbed and annulated growth stage represented by figure 5 and corresponding to Raymond's Basilicus stage of Isotelus. The original of this figure was referred by Clarke (1897, p. 712) with doubt to his Gerasaphes ulrichana, an upper Trenton species of Kentucky,

It is probable that the specimens figured do not represent the full size attained by this species; in fact we have fragments of an Isotelus from the lower Lorraine beds before us which indicate a size comparable to that of medium sized specimens of I. gigas. Among these is a part of a free cheek with a base of a well-developed spine and an eye, which is 5 mm long and 3 mm high and contains about 5000 lenses.

Homotelus stegops ranges throughout the Whetstone Gulf formation. There is also an Isotelus in the Pulaski formation. Our material of this is, however, thus far too fragmentary to determine its identity. Of the large size reached by this species, a hypostoma 34.5 mm wide gives evidence.

Homotelus ulrichi Raymond (1920, p. 287), described from the Eden of Cincinnati is, judging from the description, quite surely a synonym of this species.

Isotelus pulaskiensis Ulrich MS.

Plate 20, figure 3

There occur fragments of a large Isotelus in the Pulaski beds. None has been obtained by the writer sufficiently complete to permit the description of the species. Doctor Foerste (1924, p. 242) has collected similar material in the Lorraine of Quebec and referred it to Isotelus gigas DeKay, but also stating that the form is too rare and the material insufficient to identify the species with accuracy. Doctor Ulrich has, from specimens in the United States National Museum, recognized the specific independence of the Pulaski form and has described it as Isotelus pulaskiensis in manuscript. It is characterized by narrow genal spines and smooth pygidium with broad marginal depression.

We figure here a hypostoma from the Lorraine drift as probably belonging to this species.

Family **Proetidae** Corda

Genus **Proetus** Steininger

Proetus beecheri nov.

Plate 22, figures 12–14

Description. Animal small (largest specimen observed 11 mm long and 9 mm wide), of contracted ovate outline. Head broadly sublunate, 8 mm wide at the base and 4 mm long. Genal angles produced into sharp genal spines that extend to the fifth segment of the thorax. Marginal border broad, slightly convex, marginal doublure striated on underside. Glabella large, prominent, subtrapezoidal in outline, rounded in front; 2.7 mm long and 3 mm wide at the nuchal groove and 2.2 mm wide in front. Basal lobes more prominent than body of glabella, but set off by faint grooves only. Anterior margin distinct, separated from the marginal border of the cephalon by a narrow space equalling the width of the border. Surface of the head practically smooth in most specimens, but in some furnished with distinct anastomosing lines. Eyes prominent, close to the glabella, relatively large (1.5 mm long), with lunate, finely facetted visual surface. Facial suture starting directly in front of the palpebral lobe, passing diagonally backward in a fairly straight line to the anterior extremity of the palpebral lobe, following this inside of the visual surface and posteriorly bending outside again at an angle of about 45 degrees with a directly transverse line, cutting the posterior margin of the cephalon halfway between the dorsal furrow and the marginal border of the cephalon. A distinct mucro is seen on the center of the occipital ring.

The thorax consists of ten segments, is 5.5 mm long and 8.5 mm wide, narrowing to a posterior width of 6 mm. Axial lobe very prominent in front, one-third as wide as the thorax (3.4 mm in front in the specimen measured and 1.8 mm at the posterior end). Dorsal furrows deep. Pleurae with distinct median grooves extending to the beginning of the finely striated recurving pleural extremities. Surface also furnished with fine concentric lines, except the pleural extremities which bear distinct longitudinal lines.

Pygidium small, about 3 mm long with prominent axial lobe, that terminates slightly in front of the broad flattened, striated marginal border. The axial lobe bears seven furrows corresponding to eight annulations, only the two first of which are prominent. On each lateral lobe of the pygidium only five pleural segments can be discerned, the first of which is partly covered by the thorax but strongly marked posteriorly. The anastomosing sculpture lines are also observable on the axial lobe as fine transverse lines.

Horizon and locality. Frankfort shale at Six Mile creek near Rome and Holland Patent, Oneida county, N. Y.

Remarks. The material here described consists of ten specimens secured for the late Professor Charles E. Beecher by D. D. Luther, when collecting the famous specimens of Triarthrus "becki" and Cryptolithus with appendages. It was kindly loaned to the writer by Professor Charles Schuchert.

Beecher, in his paper on the larval stages of trilobites figured (Beecher, 1895, plate 9, figure 5) several stages of this Proëtus, referring them to Proëtus parviusculus Hall and giving also a figure of a mature individual, which is an accurate composition from several specimens.

Proëtus beecheri is distinguished from P. parviusculus, which is a later Corryville (Maysville) form, by its more subquandrangular, anteriorly less rounded glabella, narrower, convex, marginal border of the cephalon, the presence of the sculpture lines, and the distinct basal glabellar lobes.

A closely allied species is P. chambliensis Foerste (see Foerste, 1914, p. 320), which is common in the upper Lorraine beds of Quebec and eastern Ontario, but apparently absent in our Lorraine. This form agrees with our species in the outline of the head, glabella and pygidium and most details of structure. It is, however, larger, with smooth surface and lacks the mucro on the occipital ring.

The three pairs of glabellar grooves described by Foerste in his species, have not been observed in P. beecheri. They are, however, probably present, but have become indistinct through the crushing of the glabellas.

Proëtus undulostriatus (Hall), a species of the Snake Hill shale of New York and of Trenton age (see Ruedemann, 1912, p. 117) is likewise closely related to P. beecheri. It exhibits the identical sculpture lines and is very similar in the outline of the head. It is, however, somewhat larger, its glabella is more contracted anteriorly, and it lacks the mucro on the occipital ring.

The National Museum contains a specimen (no. 34490), probably referable here from the Frankfort shale at Holland Patent, N. Y., and also a small cranidium from the Econony member of the Eden shale at Covington, Ky., that while well agreeing with P. parviusculus[1] still exhibits the fine sculpture lines of P. undulostriatus and P. beecheri.

Family **Odontopleuridae**, Burmeister

Genus **Odontopleura** Emmrich

Odontopleura crosota (Locke)

Plate 22, figure 11

Odontopleura crosota, as emended by Meek (1873, p. 165) is recognizable in our lower Lorraine fauna in a minute pygidium, and the carapaces found at various horizons belong also more probably here than to O. ceralepta.

The head, reproduced in figure 11 is representative of those found in the Whetstone Gulf formation. A comparison with heads of O. parvula and O. crosota, from specimens in the State Museum, shows their extreme similarity and fails to furnish distinguishing characters, unless it is that the head of O. crosota is relatively longer and heads from the Lower Lorraine share this character.

The pygidia are more distinctly different; those of O. crosota having four long acute spines, the continuations of the ribs on either side, while O. ceralepta has but one. These ribs are distinctly curved backward. A minute pygidium, from station 6 in the Whetstone gulf, shows four such ribs, bent, however, not obliquely back but first outward and then rectangularly backward.

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[1] Professor Foerste has since published a note on P. parviusculus (Foerste, 1919, p. 387), in which it is stated that in the Cincinnati region, specimens of Proetus having the indistinct basal glabellar lobes of P. parviusculus occur as far down as the Trenton (Benson and Cynthiana members); and that the Ordovician strata of corresponding time of the New York basin carry forms with distinct basal glabellar lobes.

This species is also represented by cranidia and free cheeks in the Indian Ladder fauna (see Ruedemann, 1912, p. 51, 119).

In the fossil lists and table we have credited all occurrences of carapaces and free cheeks of Odontopleura from the lower Lorraine to this species.

We have before us specimens which we collected in the lower Lorraine (Whetstone Gulf formation) of the Whetstone gulf (stations 6, 7, 9), Mill creek (stations 10 and 15), and Wood creek (stations 2, 3, 4 and 9) and also specimens referable here from the base of the upper Lorraine (Lorraine gulf station 22a). The United States National Museum contains material from the lower Lorraine of "Totman gulf" near Lorraine and from a locality, 1½ miles east of Rome, obviously also in an association corresponding to the lowest member of the Whetstone Gulf formation. This minute acidaspid seems thus to have ranged through the lower Lorraine and possibly even into the base of the upper Lorraine.

The Pulaski formation also contains cranidia of a small Odontopleura which seem not distinguishable from those of the Lower Lorraine and are here referred to O. crosota.

Odontopleura ceralepta (Anthony)

Plate 22, figure ~~5~~ 10

Odontopleura ceralepta was described by Anthony in 1838, (p. 379) in a supplementary note to a paper by Warder, from the pygidium obtained in the neighborhood of Cincinnati. This was erroneously considered the head and, bearing two conspicuous spines, it was placed under the genus Ceratocephala, erected in the same article by Warder for species with two supposed frontal spines. Meek (1873) described and figured two more pygidia of the same type placing them under Acidaspis, and soon after Miller (1875, p. 349) referred this pygidium to his Acidaspis anchoralis, the head of which he had found on the same slab with the pygidium of Ceratocephala ceralepta Anthony. Vogdes (1877, p. 138) asserted the priority of Ceratocephala over Acidaspis and Odontopleura, placing the latter as a subgenus under Ceratocephala. Clarke later (1892, p. 97) resurrected the genus Ceratocephala for Acidaspidae with the characters of the genotype,

C. goniata Warder, a Silurian form, including also the species here under discussion in the emended genus, and pointing out at the same time that if the head and pygidium found associated by Miller, should prove to belong together, Miller's name must take its place as synonymous for C. ceralepta. While Clarke gave Ceratocephala on the ground of priority, such a wide scope that it includes Odontopleura, Acidaspis and Dicranurus as subgenera, Vogdes (1893, p. 259) only recognized Murchison's Acidaspis (erected 1839, in Silurian System) as the receptacle for the other subgenera, following therein the prevailing opinion. Raymond has now (1913, p. 722) separated the groups interesting us here into full genera, Odontopleura being characterized by a smooth occipital ring or one with but a median tubercle, Acidaspis by a single spine and Ceratocephala by two long, nearly straight divergent spines on the occipital ring.[1]

Ceratocephala ceralepta Anthony being based on a pygidium, could not be placed conclusively into any of these genera, the pygidium, as pointed out by Clarke, being quite variable in all the groups of the Acidaspidae (or more correctly Odontopleuridae Burmeister according to Raymond). Fortunately we have obtained a perfect specimen bearing the characteristic pygidium of C. ceralepta. This comes from the lower Lorraine shale (Whetstone Gulf formation) of the neighborhood of Rome (see plate 22, figure 10) and while somewhat unfavorably preserved about the head, is sufficient to demonstrate that Anthony's species is an Odontopleura and so closely related to the Trenton form O. parvula (Walcott) that we deem it sufficient to point out the differences from that species.

Odontopleura ceralepta agrees with O. parvula in the small size, our specimen being but 7.5 mm long and 5.5 mm wide; in the short broad head and apparently also in the form of the glabella. The spinose fringe of the free cheeks is present in both O. ceralepta and O. parvula, although it is not mentioned of the latter in the original description (Walcott, 1880, p. 69) or shown in Clarke's figure of the species (1897, p. 744, figure 61). This is undoubtedly due to the fact that the spinules are bent downward and therefore only visible in very few specimens and when searched for. They are likewise bent obliquely downward in O. ceralepta. The genal spine is not well shown and probably much longer than figured, or as in parvula.

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[1] Since this was written 6 years ago, further discussions of the classification of the Acidaspidae have come to hand published by R. and E. Richter (1917) and F. R. Cowper Reed (1925). The Richters distinguish seven subgenera of Acidaspis, among which Odontopleura does not appear. As Reed points out, its type species undoubtedly belongs to Leonaspis, a subgenus proposed by Richter, and Odontopleura having the right of priority, the "much disputed name" has to be revived. Ceratocephala Warder is also made a subgenus by the Richters and in a still more recent publication (1925) Ceratocephala is given priority over Acidaspis and the name "Ceratocephalidae" adopted for the family.

The thorax is as described of O. parvula by Walcott. The tubercles on the axial lobe and on the posterior elevated ridge of the pleurae are as in the Trenton species, though on account of partial exfoliation, only shown in one or two places. The anterior depressed region of the pleurae is furnished in both species with a row of eight to ten small tubercles. The hollow lateral spines of the pleurae are distinctly shorter and at the same time blunter in the Lorraine form and likewise those of the pygidium with the exception of the two long spines which are developed fully as much if not more in O. ceralepta. The tuberculation is coarser throughout in O. parvula than in O. ceralepta.

Heads and free cheeks referable to this species or the preceding appear throughout the lower Lorraine beds.

Both the species here referred to are extremely similar to the Odontopleura (Acidaspis) primordialis (Barrande) and obviously represent a type that had a wide distribution. The Ceratocephala (Acidaspis) cincinnatiensis (Meek), which occurs in the Eden of the vicinity of Cincinnati and is also based on a pygidium, belongs, judging from the latter, into the Odontopleura parvula-ceralepta group, but was a larger form.

Order **Proparia**

Family **Calymenidae** Milne Edwards

Genus **Calymene** Brongniart

Calymene senaria Conrad mut. **granulosa** Foerste and mut. **meeki** Foerste

Plate 20, figures 7 and 8

The Calymenes of the Lorraine formation have appeared under various names in the literature. The oldest of these names are Calymene callicephala Green and C. senaria Conrad. The former was, as pointed out by Clarke (1897, p. 699), undoubtedly intended for the Calymene of the Cincinnatian beds, but since the type specimen is labeled as coming from a district in West Virginia which is not known to contain any Cincinnatian rocks (see Foerste, 1910, p. 83) and since that specimen does not represent the common trilobite of the Cincinnati region, Green's name has been abandoned. Hall used C. senaria, originally proposed for the Trenton form, also for the Lorraine (" Hudson River ") species and he was followed in this identification by Meek, who carefully described the Cincinnati type, and by others. In his American Geology (1855, p. 236) Emmons described the Calymene from the " Lorraine shales " as C. conradi, obviously intending to replace by this name that of C. senaria used by Hall for the Lorraine form. Emmons describes his species as follows:

> Small, wide across the cheeks, cheek angles obtuse or rounded; posterior lobes of the glabella comparatively large and globular; thoracic lobes very convex, with a row of tubercles in the furrow or between the axis and the lateral lobes. Lorraine shales.

Foerste (1914, p. 320) states that it will be necessary to establish the species on other grounds than this description furnishes.[1] Doctor Foerste had previously (1909, p. 294) proposed the name " C. callicephala granulosa" for the Eden species of the Ohio basin, which is said by him to be distinguished from C. callicephala "by its smaller size and by the presence of numerous granules, larger and more conspicuous than in the latter species. The anterior border of the cephalon appears less strongly elevated anterior to the glabella." The same author (1910, p. 84) proposed the name " C. meeki" for the larger form of the Cincinnatian rocks, occurring above the Eden (Maysville and Richmond) and fully described by Meek (1873, p. 173). " As types, the large specimens from the Fairmount bed, with a rather extended posterior outline of the cephalon, resulting in acute genal angles are chosen."

Emmons' description of conradi is based on casts of the interior, the common mode of preservation in the Lorraine and his supposed differences are but those of preservation. On the other hand, we have failed by a comparison of our Lorraine specimens, with large series of Trenton specimens and of C. meeki from the Cincinnatian to recognize any reliable differences. It seems to us that Hall, in his description of C. senaria in volume I of the Palaeontology of New York, after having searched himself in vain for such differences, endeavors to forestall a differentiation by stating that the head is " semicircular or sublunate," thus uniting the forms with broader and narrower heads; that the head " is regularly rounded in front, or slightly projecting in front of the glabella," and that "the posterior angles (are) subacute or rounded." He thus mentioned the differences in the outline of the head, the frontal extension of the carapace and the genal angles. As shown by the specimen figured in our paper on the Lower Silurian shales (1912, compare plate 9, figures 6 and 10), the smaller specimens have a decidedly rounder head than the larger ones which have a relatively broader and shorter head. Likewise Trenton specimens vary from those with a distinct long shovel-shaped frontal extension, as that figured by Clarke (1897, p. 700, figure 3), to such "shortnosed" forms with steeply upturned short frontal extensions, as those figured by the present writer from the Canajoharie shale (1912, plate 9, figures 6 and 10) and by Foerste (1910, plate 3, figures 18 and 19). Like extreme forms occur in the material of C. meeki in our collection, from the Cincinnatian of Dayton, O. The C. senaria, figured by Clarke (see above) has very acute genal angles and we have equally acute specimens before us. On the other hand, the Trenton material also contains specimens with fully as blunt genal angles, as the Canajoharie specimens cited above have, and our material of C. meeki contains specimens both with acute and rounded genal angles. The surface ornamentation proves equally inconclusive. In smaller specimens the granulation appears relatively coarse and uniform, in the large specimens (as the one from the Canajoharie shale, 1912, plate 9, figure 10) the larger granules are widely separated and surrounded by minute ones. This feature has been noticed in Trenton limestone, Canajoharie shale and Cincinnatian examples.

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[1] In his more recent publication (Foerste, 1924, p. 245), this author has more fully set forth the lack of distinguishing characters from " The upper Ordovician " species.

The differences are then, at the best, but those of tendencies to development in certain directions, as those pointed out by Foerste, namely, to a coarser sculpture in the Eden species and to a broader base of the head in the Maysville form, these forms partaking of the nature of mutations of senaria rather than that of true species. Considering the fact that Emmons' C. conradi is based on interior casts of the carapace, while the description of C. meeki is taken from the exterior view of the carapace, and that the characters mentioned by Emmons, as the larger size of the basal lobe, are exactly those of interior casts, it is quite certain that C. conradi and C. meeki, which occur in equivalent formations of the Ohio basin and of New York, are identical. It is then a question whether Emmons' name, although it is based on an inadequate description, has not the right of priority and the species should not be emended.

For the present, for the reasons stated, we consider it least liable of creating confusion, if we identify the Whetstone Gulf specimens with C. granulosa and the Pulaski specimens with C. meeki, although our Lorraine collection is not complete enough to establish the fact of an evolutionary tendency in the mentioned directions.

The two species are briefly characterized by Foerste in his last publication (1924, p. 246) as follows:

C. granulosa — Size relatively small. Anterior border of cephalon less abruptly elevated than in Calymene meeki. Surface covered by numerous granules, larger and more conspicuous than those of the latter species.

C. meeki — Glabella relatively short, with a tendency toward truncation anteriorly. Anterior border of cephalon turned up abruptly and separated from the front of the glabella by a narrow groove. Genal angles with a short, acute, pointed extremity. Ribs of the pygidium with only a very faint trace of an impressed zone along their median line.

Hall, in Palaeontology of New York, volume 1, plate 66, figures 3*a*, 3b, has figured a thorax and pygidium from the " Utica slate " at Canajoharie as Calymene sp., citing as distinctive characters from C. senaria that " the width of the lateral lobes of the thorax, compared with the middle lobe," is greater and that " the continuous, nearly direct groove in the articulations of the lateral lobe is different from the same in C. senaria." This fragment belongs to the large variety described and figured by the writer from the Canajoharie shale (1912, p. 120). It was pointed out then that this variety is distinguished from the contemporaneous typical C. senaria by the presence of a larger tubercle on the occipital ring, and in some, as the type of plate 9, figure 6 (*op. cit.*) also on the glabella. It would seem that the great width of this form, brought out in the carapace of the larger specimen (*op. cit.* plate 9, figure 10) and the form of the pleural groove, as well as the absence or but slight development of the forward projection of the anterior ridge of the pleura constitute differences more marked than those between the Trenton and Lorraine forms. We therefore propose to distinguish this variety as C. senaria var. magnotuberculata, the specimen figured in New York State Museum Bulletin 162, plate 9, figure 10 being the type. This form apparently approaches in its broad, short head, to C. abbreviata Foerste, a Cynthiana (upper Trenton) form of Kentucky.

Family **Phacopidae** Corda

Genus **Pterygometopus** Schmidt

Pterygometopus cf. **callicephalus** (Hall)

A small cranidium found in the Indian Ladder beds proves the presence of a Pterygometopus in the faunule. The species is either identical or very closely related to P. callicephalus (Hall), no distinguishing characters being noticeable in the outline of the glabella or the glabellar furrows; the frontal lobe especially being subrhomboidal as in callicephalus, and not broadly oval and anteriorly rounded as in the Maysville form P. carleyi (Meek).

If, however, a free cheek with long genal spine, which was also found in the Indian Ladder beds, belongs to the same species, as the cranidium, then this would seem to stand between the Trenton species P. callicephalus and the Maysville form P. carleyi.

P. callicephalus will be found described and figured by Hall as Phacops callicephalus in Palaeontology of New York, volume 1, 1847, p. 247, plate 65, figures 3*a* to 3*i*. The species has been annotated and improved figures furnished by Clarke (1897, p. 731).

Subclass **Eucrustacea**

Superorder **Ostracoda**

Family **Beyrichiidae** Jones

Genus **Primitiella** Ulrich

Primitiella unicornis (Ulrich)

Plate 23, figure 6

Primitiella unicornis was first described by Ulrich (1879, p. 10) from the basal beds of the Cincinnatian series (Fulton beds) at Cincinnati, Ohio; and again more fully noted in his " Lower Silurian Ostracoda of Minnesota, (1897, p. 649).

Varieties of this species have also been observed in the Bala shale of Montgomeryshire, England (Jones, 1890, p. 7) and in the lower Canajoharie shale of New York (Ruedemann, 1912, p. 121). It is, in Bulletin 258, recorded from the upper Canajoharie shale in the Nowadaga-Ohisa creek section, and the Whetstone Gulf formation in the Whetstone gulf (station 6, in zone 1), Totman gulf and neighborhood of Rome. While here this species is extremely common in the Canajoharie shale, it is rather rare in the lower Lorraine (Whetstone Gulf) shale.

We have found this species also to be a common member of the fauna of the Gloucester shale of the neighborhood of Ottawa (United States Natural Museum no. 372). Here, however, the spine is short and blunt, hardly more than a mucro, while, at the other hand, in the material from the Canajoharie shale it is remarkably acute (see Ruedemann, 1912, plate 9, figure 14).

Family **Leperditiidae** Jones

Genus **Aparchites** Jones

Aparchites minutissimus (Hall)

Plate 23, figures 1 and 2

Aparchites minutissimus was first described by Hall as Leperditia (Isochilina) minutissima in the 24th Report of the New York State Museum (1872, p. 231), from specimens coming from the Eden at Cincinnati. The species has later been recognized to range from the Eden to the Richmond and to occur at various localities in the Ohio basin, as well as in Canada. In New York it has been observed in both the Whetstone Gulf and Pulaski formations, sometimes as a common form, as at station 22a in the Lorraine gulf section and station 9 in the Whetstone gulf section. It is a rather constant form throughout the Whetstone Gulf shales, is less common in the lower Pulaski beds and has not been found in the upper Pulaski beds. We have also specimens from the upper Utica at Holland Patent and the Frankfort shale at Six Mile creek near Rome, N. Y.

While most of the specimens are evenly convex, some also show the obtusely pointed subcentral prominence, noted by Hall and by Ulrich (1889, p. 49). Many of our shale specimens are casts of the interior and show a faint median depression below the dorsal line.

Genus **Primitia** Jones and Holl

Primitia centralis Ulrich

Plate 23, figure 7

Original description (Ulrich 1890, p. 130). Carapace suboblong, the dorsal edge straight, the ventral elliptically curved, the anterior end somewhat narrower and more sharply curved, both ends meeting the dorsal edge without forming distinct angles; free borders with a narrow flange, best developed along the posterior edge. Sulcus represented by a sub-central depression, not reaching the dorsal margin. Surface smooth.

Size: Length, 0.6 mm; height, 0.35 mm
Length, 0.75 mm; height, 0.48 mm

Bassler (1915, p. 1029) records this species as ranging from the upper Trenton to the Maysville and as occurring in the vicinity of Cincinnati, and Foerste has since (1916, p. 92) discovered it also in the Eden shale of Manitoulin Island.

Ulrich distinguishes a wider and larger form which occurs in the Utica (Fulton) shale and a narrower, smaller form which occurs in the higher Cincinnatian beds. It appears that our material belongs to the first variety and inclines to be still wider than Ulrich's type. It would also seem to have the flange still more distinctly developed.

The species is rare at station 4 of the Lorraine gulf section (zone I of Whetstone Gulf formation). Specimens probably referable here have also been found at the next three stations.

Primitia rudis Ulrich

Plate 23, figures 3–5

This " unshapely " type of ostracod has thus far been recorded only as rarely occurring in the Eden (Economy) beds at Covington, Ky. It is described by its discoverer as follows (Ulrich, 1890, p. 136):

> Carapace oblong, subelliptical, the two extremities nearly equal and most convex in the lower half; dorsal edge slightly convex; ventral margin gently rounded, almost straight in the middle third, with an indistinct flange. Sulcus rather wide, well impressed, but more sharply defined on the anterior side than on the posterior, extending from the dorsal border obliquely forward to the center of the valve. In front of the sulcus and between it and the dorsal margin a faintly defined tubercle or lobe. Posterior half the most convex, the slope of the edge from point of greatest convexity, somewhat flattened. An undefined depression in the posterocardinal region.
>
> Size: Length, 1.0 mm; height, 0.5 mm.

Our specimens are a little smaller, averaging but .8 mm in length, and at the same time relatively a little wider and more convex on the ventral margin than the typical form, but evidently, as shown by the figures here given, subject to some variation as to outline, relative width and length.

Primitia rudis has been observed in the lowest zone of the Whetstone Gulf formation, at stations 4, 5, 6, 7 of the Lorraine gulf section and stations 6, 7 and 9 of the Whetstone gulf section. It has also been recognized among the Frankfort fossils from Six Mile creek near Rome, N. Y. (United States National Museum specimens.)

Genus **Jonesella** Ulrich

Jonesella pedigera Ulrich

Plate 23, figures 13–15.

For *original description* see Ulrich, 1890, p. 122.

The peculiar shape of the ridge, shaped like the head of a shepherd's crook, in this species serves well in distinguishing it from all other Ostracoda known to me.

This species occurs according to Bassler in the Eden (Economy) of Covington, Ky., and vicinity, and it has also been recorded by Foerste (1916, p. 92) from the Eden shale at Gorrel Point, Manitoulin Island. It has been found by us to be a very common fossil in certain beds of station 6 of the Lorraine gulf section.

Our specimens seem to be slightly larger than the Covington material, the average examples here figured measuring 1.2 mm by .65 mm, and 1.2 mm by .7 mm (two). The figures illustrate the variations in the form of the ridge observed on the same slab.

Genus **Bollia** Jones and Holl

Bollia uticana nov.

Plate 23, figure 9

Description. Valve suboval, the anterior end slightly narrower than the posterior; the dorsal margin convex; the anterior margin somewhat sharply rounded, the posterior margin nearly straight, the ventral margin fairly evenly rounded; the antero-dorsal angle very obtuse, the postero-dorsal angle rounded and slightly obtuse. The horseshoe ridge occupying the upper half of the valve, the upper arms club-shaped and the extremities expanded into bulbous swellings which project slightly above the dorsal edge and are connected by a thin ridge, surrounding a deep circular perforation from which rises a small knob. Halfway between the horseshoe ridge and the margin a very sharply elevated ridge runs parallel to the edge, except in the upper posterior portion. The free edge is also slightly turned up. Surface smooth.

Measurements. Length, .85 mm; height .5 mm.

Horizon and locality. Upper Utica shale at Holland Patent, N. Y.

Remarks. We have three valves of this species on one slab, only one of which, however, is very finely preserved and this is figured as the holotype.

B. uticana is in outline, size and general characters so extremely similar to B. pumila Ulrich that we would not have hesitated to consider it an earlier mutation of that species if there were not the long time interval from the lowest Utica to the Waynesville bed of the Richmond that separates the two forms. The main difference is found in the form of the bulbous terminations of the horseshoe ridge, which in B. pumila are sharply separated as semispherical bodies from the thin connecting ridge while in B. uticana they are placed on club-shaped expansions of the ridge. The bulbous bodies themselves are less spherical and more button-shaped. The central knob in B. uticana may furnish another difference, and the failure of the submarginal ridge to reach the posterodorsal angle may be a further differential character. All these differences may prove, however, but varietal ones when the gap is filled by the finding of specimens in the intervening beds.

Bollia pulchra nov.

Plate 23, figures 9–12

Description. Valves compressed, subcircular in outline in smaller, subovate in mature specimens, straight above; dorsal angles rounded; anterior and posterior marginal ridges broad and flat, the anterior more distinct than the posterior which is barely noticeable, as a narrow thickened edge; these ridges are connected along the ventral margin by a very thin raised line inside of the beveled edge; inner, horseshoe-shaped ridge somewhat variable, but in typical specimens slightly bulbous and strongly projecting at the ends while the bent connecting ridge is lower and either very narrow or with a narrow ridge on top of a broader base. One of the arms of the horseshoe ridge, usually the anterior is liable to be more bulbous — with suggestions of a terminal node — than the other, which may be straight club-shaped. In young specimens this ridge is nearly circular, in old individuals it shows a tendency to angularity at the inner corners. Surface smooth.

Measurements. Length .80 mm; height .48, thickness not quite one-half of length.

Horizon and locality. This species occurs in the lower Lorraine (Whetstone gulf shale) at stations 6, 7 of the Lorraine section, station 6 of the Whetstone gulf section, and is also found at stations 9 and 10 of the Moose creek section and at stations 1 and 2 of the Wood creek section. It is thus here a form of the lowest (Economy) zone of the Lower Lorraine. It is also common in the material in the Rust collection from the neighborhood of Rome (no. R 1232 of State Museum).

Bollia sp. aff. **pulchra** nov.

The upper Utica shale at Holland Patent, N. Y., contains, as a rare fossil, a form of Bollia that is apparently related to the Lorraine species pulchra but differs in possessing more bulbous ridges, which occupy a larger portion of the surface of the valve. The arms of the horseshoe-shaped ridge are both nearly vertical and more prominent than the broad connecting ridge; which slopes toward the ventral margin. The specimen figured, measures .6 mm in length and .44 mm in height.

The material now available is not sufficient to establish the characters of the form without doubt.

Genus **Dilobella** Ulrich

Dilobella lorrainensis nov.

Description. Valves subovate to nearly semicircular; dorsal outline straight, well-rounded at the ends; anterior and posterior margins strongly convex, the ventral margin slightly less. A deep straight vertical sulcus, somewhat anteriorly of the middle, extends about two-thirds the height of the valve. The two lobes are subequal, broadly clavate, sharply set off from the border which is nearly flat, declining gently towards the margin, broadest posteriorly and steepest ventrally, and surrounded by a steeply beveled edge.

Measurements. Length of type specimen .7 mm; height .68 mm, thickness not quite one-half of length.

Horizon and locality. Common in a shaly layer at stations 9 and 10 of Mill creek section (zone I of Whetstone Gulf formation).

Remarks. This species shows a certain superficial similarity to Bollia pulchra, which is found in the same zone; it differs in being shorter in outline, but especially in greater bulbosity of the lobes and the lack of anterior and posterior marginal ridges. Nevertheless we feel not sure that it may not be directly derived from that more common form and represent an extravagant development of the same, similarly as the genus Dilobella is probably, according to Ulrich, such a development of the Bollia type of structure. As the species is common in one layer, and there holds its characters without considerable variation, it deserves recognition, whatever its genetic relations may be to the species of Bollia.

Genus **Ceratopsis** Ulrich

Ceratopsis oculifera (Hall)

Plate 23, figures 17–20

This species has been found only in casts of the interior in the sandy Lorraine limestone at Pulaski and is therefore identified with some difficulty with the Maysville types. The figures of our specimens give therefore only an imperfect idea of the characters of this interesting form.

The species, which is thus far known only from the Maysville (Corryville) of Cincinnati, Ohio, and vicinity, and the St. Hilaire section in Quebec (Foerste 1916, p. 45), was first described and figured by Hall (1872, p. 232). Its characters have since been still more elaborated by Jones (1890, p. 21) and Ulrich has referred the species to his genus Ceratopsis (1897, p. 676); a genus of Tetradella-like forms in which the postero-dorsal extremity of the marginal ridge rises into a strong spinelike or otherwise shaped process. The latter not being preserved in the casts, the specimens appear at first sight as belonging to a Tetradella.

The largest specimen observed is 1.6 mm long and 1 mm high, another 1.4 mm long and .8 mm high.

All the specimens were obtained in the highest beds of the Pulaski section (station 22).

Ceratopsis chambersi (Miller)

As Beyrichia chambersi Miller (1874,p. 234) has described this form from the Cincinnatian of Ohio.

Ulrich (1897, p. 676) has referred the species to his genus Ceratopsis and restricted the former to the earlier (Trenton and Black River of Minnesota, Eden of Ohio) type, separating the later, Richmond form, which Miller also had included in his species, as C. robusta. He gives the following additional note on the species, as restricted by him:

> The principal distinguishing feature of this abundant species is the spinelike form of the postdorsal process. In the typical variety, the postmedium ridge is short and small. It is so in all the Trenton specimens and in the lower Cincinnati group types of the species.

While in the West the species occurs in both the Black river — Trenton and Eden groups, it has in New York been found so far only in the Indian Ladder beds (Ruedemann, 1912, p. 51 and 121).

Some of our specimens have the upper end of the postmedian ridge separately developed as a small rounded node, a feature also observed by Ulrich in one case and considered by him as possibly abnormal. We were inclined to consider this before (1912, p. 121) as a distinctive character marking a variety. Further material from the Indian Ladder proves however, that the majority of the specimens do not show this character and do not differ from the typical C. chambersi.

Family **Cypridae** Zenker

Genus **Bythocypris** Brady

Bythocypris cylindrica (Hall)

Bythocypris cylindrica was first described by Hall (1872, p. 231) as Leperditia (Isochilina) cylindrica, from specimens from the " Hudson River group " (probably Eden) at Cincinnati. It was very fully figured and its relationships elaborated by Ulrich (1897, p. 687). It is now known to range from the Trenton to the Richmond and to have a wide geographic distribution extending from Quebec (Foerste, 1918, p. 21) to Manitoba and Tennessee. In New York it has before been recorded by the writer as abundant in the Rysedorph Hill conglomerate (1901, p. 86) and been found to occur profusely in the lower Lorraine (Whetstone Gulf) formation, and less commonly in the lower Pulaski formation. It is in this paper also cited among the fossils of the uppermost Canajoharie shale.

Family **Entomidae** Jones

Genus **Elpe** Barrande

Elpe radiata (Ulrich)

Plate 23, figure 16

For original description see Ulrich, 1878, p. 2.

This species, which is readily distinguished from all associated ostracods of the Utica and Lorraine formations by the form of the valves and the radially striate surface, was hitherto known only from the Fulton (Utica) beds of the First Ward, Cincinnati, Ohio. Of the specimens here figured, one has been collected in the black Deer River shale at the mouth of the Lorraine gorge and was kindly identified for the writer by Doctor Ulrich as belonging to his species. This specimen is 1.9 mm long and 1.77 mm wide.

The United States National Museum contains a small series of specimens, one of which is labeled as coming from the " Utica shale, 8 miles north of Rome, N. Y." (Rust collection) and another, "Utica shale?, Rome, N. Y." The locality given, as well as the character of the rock and the associated fossils (Orbiculoidea tenuistriata, Leptobolus insignis, Triarthrus eatoni), indicate the Frankfort age of the specimens.

Two of these are worth special mention; one for exhibiting a deep median sulcus on the internal mold that shows the presence of a strong clavicle upon the interior shell, presumably for the attachment of the adductor muscles. The other, also an interior view, retains a powerful internal ligament that in opening the valves interacted with the before-mentioned adductor muscles. The presence of such a strong ligament is also noticeable in the internal casts of other species of Elpe, as E. cincinnatiensis (see Meek, 1873, plate 14, figure 1*d*) through the interruption of the contact-line of the valves. It is due to this strong ligament that the two valves are, in E. radiata, nearly always found still connected along the hinge-line.

Superorder **Cirripedia**

Family **Lepidocoleidae** Clarke

Genus **Lepidocoleus** Faber

Lepidocoleus jamesi (Hall & Whitfield)

Plate 25, figure 1–3

This species of cirripede crustacean was first described (1875, p. 106), from the Cincinnatian of the neighborhood of Cincinnati, from detached plates and referred to Plumulites. Later, Faber (1886, p. 15) described an entire specimen and erected the genus Lepidocoleus for cirripedes whose body is covered by two columns of plates. The genus became still more fully known from a Silurian type, described by Clarke.

Plates alike to those described from Cincinnati occur in New York from the Trenton upward to the top of the Lorraine. They have been described and cited by the writer (1901, 102) from many localities in the Canajoharie and Snake Hill shales and the Indian Ladder beds; and observed by him in the Trenton limestone (1901, plate 2, figure 10). In the Lorraine section they are a fairly regular component of the shale faunas.

In the Pulaski beds at Worthville, N. Y (station 22) there occur together with the normal triangular plates, as figured by Hall and Whitfield, narrow leaflike plates with a distinct median rib and very faint transversal lines (see figure 1). A plate of this character, though relatively wider, has already been figured by the writer in New York State Museum Bulletin 42, plate 2, figure 11, and referred to Lepidocoleus jamesi.

While both the known entire specimens, that of L. jamesi and that of L. sarlei, do not exhibit any plates of this character, it is generally assumed that these plates which have been observed in various formations belong to the peduncle not hitherto found (*fide* Clarke).

The separate plates from the different formations do not indicate any specific differences, although it is quite probable that such exist between the Trenton and Lorraine representatives.

Family **Balanidae** Darwin

Eobalanus informans Rued.[1]

Plate 24, figures 1–4

Description. Wall elliptic or oval in outline, the major and minor diameters to each other as 4:3; consisting of twelve free plates, (termed compartments) five symmetric lateralia, and the asymmetric carina and rostrum. Scuta and terga have not been observed. The lateralia are wedge-shaped but so arranged that they interlock, the outer pairs being broadest at the base (outside), the next pair also narrowing toward the top but with the apex truncated, the middle pair, however, widest at the top, thus forming a sort of keystone in the series of plates. One of the asymmetric plates is somewhat larger than the other, this end of the wall having been apparently more acute than the other, producing an oval outline. These wall plates were inserted in an elliptic base the impression of which projects slightly beyond the basal edges of the wall-plates.

The surface of the compartments is smooth; save the growth-lines that run parallel to the basal margins.

Measurements. The largest specimen observed measures 28 mm in length and 23 mm in width, a smaller complete specimen is 9 mm long and 7 mm wide.

Horizon and locality. All specimens observed were attached to the conchs of Geisonoceras, mainly G. amplicameratum, from the Utica shale at Holland Patent.

Remarks. Doctor A. F. Foerste, during one of his visits to the State Museum, directed attention to the fact that Billings had figured a fossil similar to this species. He had in mind the Aspidella terra-novica, from the "Huronian" near St Johns, Newfoundland (see E. Billings; Palaeozoic Fossils, volume 2, part 1, 1874, figure 45). This fossil is described by Billings as small and ovate in size and outline, with "a narrow ringlike border, within which there is a concave space all around." "In the middle there is a longitudinal rooflike ridge, from which radiate a number of grooves to the border. The general aspect is of a small Chiton or Patella, flattened by pressure. It is not probable, however, that they are allied to either of these genera."

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[1] This species as well as a Trenton congener have been described in an earlier paper entitled: An Ancestral Acorn Barnacle (N. Y. State Mus. Bul. 251, 1924, p. 93–104). There also the phylogenetic significance of this discovery has been **fully discussed.**

It is true that this fossil, as figured by Billings, shows a certain similarity to Eobalanus, although the radiating lines would suggest a much greater number of plates. Although Aspidella terranovica appears in some of the older textbooks as a Precambrian fossil, it seems to have early fallen under suspicion. It is not any more cited by G. F. Matthew among the Upper Huronian Fossils of Newfoundland in 1910 (The Sudden Appearance of the Cambrian Fauna, C. R. du XI:e Congr. Géol. Int., p. 558) and Thomas H. Clark has more recently (New Fossils from the Vicinity of Boston, Proc. Boston Soc. of Nat. Hist., volume 36, no. 8, 1923, p. 484) declared these structures to be of inorganic origin and probably marking the sites of vents of escaping gas.

The discussion on the phylogeny of the Cirripedia to which the discovery of Eobalanus has led, is beyond the scope of this bulletin.

Superorder **Malacostraca**

Division **Phyllocarida**

Order **Nebaliacea**

Family **Ceratiocaridae** Salter

Genus **Ceratiocaris** Salter

Ceratiocaris (Limnocaris) timida nov.

Plate 25, figure 4

Description. Carapace-valves small; pod-shaped; twice as long as wide; widest at the middle or a little in front of the middle. Dorsal margin straight or gently convex; anterior margin contracted into an acute point a little above the median line; ventral margin fairly evenly rounded, posterior margin truncated with rounded corners. The eye-tubercle is distinct, large and situated well forward. The abdomen is large and protruding a distance equalling the length of the carapace; it consists of about twelve segments, five to six of which are seen within the carapace. The telson is relatively short and blunt; the cercopods have not been observed. Surface-sculpture not known.

Measurements. Largest specimen (type) possesses a carapace 31.5 mm long and 16.5 mm high.

Horizon and locality. Upper Utica shale (zone of Climacograptus pygmaeus) at Holland Patent, N. Y.

Remarks. This species is based upon a dozen specimens that were found sheltered in the paragastral cavity of a sponge, probably a Teganium, which has lost all trace of spicules except in one spot, while the walls as well as the paragaster and osculum are still distinctly outlined, the now projecting paragaster having become filled with mud to some extent and thus preserved. The carapaces for the most part are covered by the film which resulted from the overlying wall of the sponge and therefore while distinct as to their outlines and eye-tubercles, are lacking the sculpture markings, if there were any originally.

The specimens vary greatly as to outline and size; the differences in outline are obviously due to different positions of the carapace to the direction of compression; and the narrow, slender carapace-valves are more or less turned under along the ventral margin.

The eyes appear as distinct tubercles in several specimens, and the species belongs therefore to the subgenus Limnocaris Clarke of Ceratiocaris.

The preservation of a dozen individuals of a crustacean, of which no other trace is observable in the large Utica collections, within the paragaster of a sponge, sheds some interesting light on the failure of preservation under normal conditions of forms that may have been quite abundant in the sea.

Ceratiocaris sp. ?

Plate 26, figure 6

A slab of black shale from the Whetstone gulf shale near Rome (collected by Valiant, in Rust collection) bears three rigid, straight bayonetlike spines, one with a narrow sharp median keel, the other with a blunter keel and two parallel narrow ridges, the third and smallest with a keel in the distal portion and a shallow median depression in the proximal portion. These strange bodies which possess a fairly strong carbonaceous test and were apparently flat or elongate rhombic in section, suggest at first glance the possibility that they may be leg-spines of the Echinognathus noted in this paper from the Frankfort shale. These leg spines are, however, always strongly curved, while those before us are rigidly straight and dagger-like, and rather flat in section, suggesting by these features the telson spines of a Ceratiocaris-like crustacean. Their chief interest, as with other fragments here described, lies in indicating the presence in the Frankfort and Utica shales of peculiar organisms, that still await their resurrection from the black shales.

Class **Arachnida**

Subclass **Merostomata**

Order **Eurypterida**

Family **Eurypteridae** Burmeister

Genus **Echinognathus** Walcott

Echinognathus clevelandi Walcott

Plate 26, figure 5

The genus Echinognathus and the species E. clevelandi are both based on material from the Utica shale at Holland Patent. The original specimens described by Walcott (1882, p. 152) consisted of a segment and a walking leg. These specimens have been refigured and the relationship of the genus discussed by Clarke and Ruedemann (1912, p. 322). Ruedemann has later (1916, p. 108) described additional parts, namely, a supposed carapace, a metastoma and a very large leg spine, the latter probably from the Frankfort shale at Rome, while the others are from the Utica shale at Holland Patent. All these fragments seem to indicate a close relationship of Echinognathus to Eusarcus, and for Echinognathus clevelandi a size of a meter or more.

On account of the interest that attaches to all parts of these strange marine arachnids, we add here the figures of further fragments, also obtained at Holland Patent. The first of these, a small portion of a segment, is remarkable for the very large size of the scales, indicating a very large individual, and further for the row of large overlapping, keeled marginal plates of the segment, which represent a feature, that in this extreme development is probably gerontic in the individual and has not been noticed before in the eurypterids of New York, though recalling a leg of an undescribed Stylonurus (see Clarke & Ruedemann, 1912, plate 53, figure 7) from Otisville, N. Y.

Another fragment, from the collection of the National Museum, represents half the operculum. This is indicated by the articulating process in the upper left corner and the small transverse width of the fragment. The droplike scales of part of the segment are distinctly seen if the specimen is turned at the proper angle towards the light; likewise the peculiar sculpture of the posterior margin is readily observed in the proper light, notwithstanding the extreme crumbling and flattening that the flexible test has suffered.

The flat fragment of test obviously served as cover and refuge for a number of lamellibranchs (Prolobellas), some ostracods and other organisms.

Stylonurus sp.

Plate 26, figure 5

Under this heading may be mentioned the leg segment, reproduced in plate 26, figure 5. This is characterized by its slender form, indicating a long walking leg such as Stylonurus possesses. To the latter genus point also the peculiar long linear scales of the upper portion of the joint, which toward the lower and more distal part are replaced or merge into deep flutings.

The fragment lies associated with abundant Cryptolithus bellulus, specimens of Isotelus stegops and crinoid joints, on a slab of argillaceous sandstone from the Whetstone Gulf formation near Rome (Rust collection).

Genus **Eurypterus** Dekay

Eurypterus ? rusti nov.

Plate 27, figure 1; plate 28

This species is based upon a carapace, three tergites and a postabdomen with telson. All were found in a large patch of carbonaceous matter, such as occur in the Utica shale at Holland Patent. This particular patch, on closer inspection, dissolved itself into a nearly entire specimen of Pterygotus (see P. walcotti) and the above-mentioned fragments of an Eurypterus.

The species, judging from these remains, was of medium size. The carapace approximately semielliptic, the length about two-thirds the width, the outline fairly uniformly rounded, the posterior margin very slightly convex. The lateral eyes are large, one-third the length of the carapace; lunate in outline; far apart, distant from the lateral margin by their own length; situated on both sides of the central portion of the carapace. Ocelli not positively recognized, possibly situated on a line connecting the posterior extremities of the lateral eyes. Tergites short and wide, about 7 times as wide as long; distinctly curved backward in the middle portion. No traces of sculputure were observed, the plates being seen from the inside.

Associated with the carapace are two fragments of postabdomina which are those of an Eurypterus or Stylonurus and presumably belong to this species. They are slender, gradually tapering, the segments about as long as wide; the telson is a very slender spine, rapidly contracting in the first third of its length.

Measurements. The carapace is 24 mm long and about 39 mm wide opposite the eyes; the eyes are 9 mm long. The second tergite is about 7 mm long and 41 mm wide. The fragmentary postabdomen, retaining four segments and the telson, measures 89 mm and is about 21 mm wide at its anterior end and 9 mm at the base of the telson.

Horizon and locality. Upper Utica shale (zone of Climacograptus pygmaeus) at Holland Patent, Oneida county, N. Y.

Remarks. The appendages being lacking, there is some doubt as to the proper generic reference of this species, for there is a bare possibility that the form may belong to the Stylonurus group, although the telson is not quite so styliform as it is in that genus.

The species is not in danger of being confused with any of the eurypterids described by Clarke and Ruedemann from the Schenectady beds of New York.

Genus **Dolichopterus** Hall

Dolichopterus insolitus nov.

Plate 26, figure 1

Description. Body small, subfusiform. Cephalothorax broadly subquadratic, about one-fourth wider than long. Lateral margins subparallel, but gently curved, antero-lateral angles well-rounded, anterior margin slightly convex; posterior margin slightly concave. Lateral eyes (?) small, reniform, situated forward near the antero-lateral corners. Ocelli not distinctly seen. Abdomen gradually widening to the third and fourth tergites, thence more abruptly contracting. Postabdomen and telson not observed. Tergites narrow plates, 6 to 7 times as wide as long. Appendages and surface sculpture not known.

Measurements. Length of cephalothorax and abdomen 32.5 mm; greatest width of abdomen 22 mm; length of cephalothorax 12 mm; width at base 16 mm; length of lateral eyes 2 mm; length of second tergite 3 mm; width 21 mm.

Horizon and locality. Upper Utica shale (horizon of Climacograptus pygmaeus) at Holland Patent, N. Y.

Associated on same slab with Trocholites ammonius major, Eusarcus breviceps, Leptobolus insignis, Climacograptus pygmaeus and numerous eurypterid fragments.

Remarks. This species is based on the single specimen figured and therefore is still imperfectly known. The cephalothorax is, however, well characterized by its outline and the forward position of its lateral eyes. These two features will distinguish it at once from the larger Eurypterus rusti, which has a broader, more evenly rounded cephalothorax and larger, more centrally located eyes.

There is none of the eurypterids of the Schenectady beds, with which it could possibly be confused, except perhaps D. frankfortensis, which has, however, a more elongate carapace and the lateral eyes placed nearer to the antero-lateral angles. It is principally on account of this position of the eyes that we have placed this species provisionally with Dolichopterus; considering it quite possible that later discoveries of more complete material will prove it to be an Eurypterus.

Genus **Eusarcus** Grote and Pitt

Eusarcus breviceps nov.

Plate 26, figure 2

Description. Body of small size, compact subfusiform in outline. Cephalothorax semi-elliptic, twice as wide as long. Lateral margins fairly rounded, converging forward; anterior margin transverse, short, produced in the middle into a short trapezoidal process; at the basal angles of which the relatively small oval lateral eyes are (apparently) situated. Posterior margin straight transverse. Ocelli large, situated on a large monticule that lies a little anterior to the center of the cephalothorax. Abdomen but little wider, at third segment, than the posterior margin of the cephalothorax. Of the five tergites that can be discerned, the first is the narrowest; it is 11 times as wide as long, the others are about 7 times as wide as long.

Measurements. Length of cephalothorax, (exclusive of frontal process) 16 mm; greatest width, at base, 35 mm; length of frontal process 2 mm; length of lateral eyes 1.8 mm; diameter of ocellar monticule 4 mm; width of first tergite 33 mm; length 3 mm; width of third tergite 35 mm; length 5 mm.

Horizon and locality. Upper Utica shale (zone of Climacograptus pygmaeus), Holland Patent, N. Y.

Remarks. This species, by its broad, short cephalothorax, the anterior lingulate process and the forward position of the eyes, belongs to the group of species typically represented by the Silurian form Eusarcus vaningeni Clarke and Ruedemann. In the position of the eyes at the base of the lingulate process, it shows an even more extreme development than this later species, but is still anticipated by the Normanskill species Eusarcus linguatus Clarke and Ruedemann.

Family **Pterygotidae** Lankester

Genus **Hughmilleria** Sarle

Hughmilleria uticana nov.

Plate 26, figure 3

A single specimen retaining the carapace and the greater part of the abdomen has been observed. This compares in size to the genotype H. socialis. It also is very similar to that Silurian species in general outline and that of the carapace.

The carapace is semi-elliptic, about one-fourth wider than long; sides gently curved, while the front is acutely rounded. The posterior edge is slightly curved forward. A thickened border, about one-half mm wide, surrounds the lateral and frontal sides. The compound eyes are marginal, situated rather far forward, at the antero-lateral angles, elongate, of approximately semi-elliptic shape, the outer margin being nearly straight, the inner strongly convex; about one-third the length of the carapace.

Of the preabdomen the operculum and several of the other ventral plates (sternites) are discernible, the latter quite indistinctly as to their posterior margins. The operculum bears an ovipositor of about its own length, and of the characteristic outline of that of Hughmilleria, namely, with a sagittate basal portion and an apparently simple distal sheath of semitubular shape. The distal extremity seems to be subtriangular. The genital appendage of the following sternite is merely suggested but not distinctly seen.

The surface of the operculum is provided with fine transverse, mostly parallel, but also anastomosing lines.

Of the postabdomen five segments and a fragment of the telson can be distinguished. The postabdomen is gradually decreasing in width, the anterior segments being wider than long, while the last one is about as wide as long.

Measurements. Length of fragment (which is contracted) 97 mm; greatest width 28 mm. Length of carapace 17 mm; width 22 mm. Length of compound eye 5 mm; that of operculum 16 mm. Length of second postabdominal segment 8 mm; that of last one 5.5 mm.

Horizon and locality. Upper Utica shale (zone of Climacograptus pygmaeus) near Holland Patent, N. Y.

Remarks. This species is quite safely considered as a typical Hughmilleria, although the appendages and telson are lacking; for the shape of the carapace, the position of the compound eyes, the ovipositor of the operculum and the transverse sculpture of the latter are peculiarly characteristic features of that genus. The transverse sculpture is most typically developed in H. shawangunk from the Shawangunk (Silurian) beds of New York. With this species, which it also resembles in general outline, our form may be compared as its nearest relative among the small number of congeners that are known by more than their carapaces. It is also comparable to H. magna from the Schenectady beds of Schenectady, N. Y., a somewhat older form, which also possesses a transverse linear sculpture of the segments (see Clarke and Ruedemann, 1912, plate 85, figure 19), but may be distinguished by the more intramarginal position of the eyes and the relatively greater width of the carapace.

The specimen here described gives a wrong impression as to the outline of the body, the postabdomen being pushed forward into or upon the abdomen and the body being thus unnaturally shortened.

Genus **Pterygotus** Agassiz

Pterygotus walcotti nov.

Plate 27, figure 1; plate 28

Description. Species, as represented by holotype, below medium size. Body short and compact for a pterygotid, lanceolate in outline, about 4 times as long as wide. Carapace short and broad, semielliptic in outline, only about one-sixth to one-seventh the length of the body; the length about two-thirds the width; greatest width at the posterior margin; lateral margins fairly evenly convex; posterior margin gently concave in the middle. Surface sculpture not observed. Lateral eyes marginal, large (a little more than one-third the length of the carapace), elongate elliptic. Median eyes not found.

Abdomen relatively short and broad, about 3 times as long as wide, widest at the third and fourth tergites; gradually expanding to maximal width and more rapidly contracting in the last tergites. Tergites broad bands, about 4 times as wide as long, with almost straight anterior and posterior margins. Postabdominal segments short and subcylindrical, the penultimate wider than long. But faint traces of sculpture preserved. Last segment trapezoidal in outline, as wide as long, widest along the posterior margin where it is broader by about one-third than at the anterior margin. The lateral margins almost straight, the posterior margin produced in the middle into a subtriangular lobe. Surface furnished with two diverging double lines of punctae. Telson not observed.

Ventral side and appendages not known.

Measurements. Length of body (lacking telson) 153 mm; greatest width 38 mm (conjectural measurement); length of carapace 22.5 mm; width 35 mm. Length of preabdomen 61 mm; width 38 mm (conjectural); length of postabdomen 55 mm; width of last segment 20 mm; length of same 18 mm.

Horizon and locality. Upper Utica shale (zone of Climacograptus pygmaeus), Holland Patent, N. Y.

Remarks. This eurypterid was recognized in one of the large carbonaceous patches occurring in the Utica shale at Holland Patent (see Eurypterus ? rusti), and collected by Walcott and Rust many years ago.

Although the subtriangular carapace is more suggestive of its reference to Hughmilleria, we have referred the species to Pterygotus because the last postabdominal segment is so strongly expanded that it could not have served as basis for a slender telson-spine as seen in Hughmilleria, but instead for a broad rudderlike organ as in Pterygotus, where the ultimate segment is likewise shaped as in our specimen. This Utica form seems thus to hold an intermediate position between Hughmilleria and Pterygotus, possibly leading from the former to the latter. If such intermediate type, it should properly be distinguished by a different generic term, but owing to the lack of the telson and appendages its true relationship can not be determined conclusively.

The species is by the outline of its head readily distinguished from the forms of Pterygotus and Hughmilleria, described by Clarke and Ruedemann from the Schenectady beds of New York.

List of Species and Varieties of Utica and Lorraine Formations of New York

Abbreviations: D. R. = Deer River shale. At = Atwater Creek shale. Col. = Collingwood shale. L = Lorraine beds in general. I = Part I (Bulletin 258), II = Part II (Bulletin 262), III = Part III (Bulletin 272).

NO.	NAME	Utica shale	Indian Ladder shale	Frankfort shale	Whetstone Gulf shale	Pulaski shale	References (page)
	Plantae						
1	Sphenophycus lobatum Rued	X					II, 6
2	S. succulentum Rued	X					II, 7
3	Discophycus typicale Walcott,	X					II, 8
4	Delesserella [1] salicifolia Rued	X					II, 8
5	Palaeophycus fluctuans Rued					X	II, 10
6	Rhombodictyon irregulare Rued	X				(top)	II, 11
	Spongiae						
7	Cyathodictya reticulata Walcott	X					II, 14
8	C. (?) walcotti Rauff	X					II, 18
9	C. (?) pyriformis Rued	X					II, 19
10	Sphaerodictya subsphaerica Walcott	X					II, 21
11	Teganium subsphaericum Rauff	X					II, 23
12	I. macrosclera Rued	X					II, 26
13	Foerstella rotunda Rued	X					II, 30
14	F. flabellata Rued	X					II, 31
15	Polyplectella mira Rued			X			II, 32
16	Sycodictya rara Rued	X					II, 34
17	Pyritonema capilliforme Rued	X					II, 37
	Incertae sedis						
18	Clionolithes quaerens Rued				X		II, 38
19	Ischadites circularis Emmons					L	II, 40
	Anthozoa						
20	Columnaria alveolata (Goldfuss)					L	II, 41
	Graptolitoidea						
21	Dictyonema arbusculum (Ulrich)		X				II, 41
22	Callograptus compactus (Walcott)	X					II, 42
23	Mastigogr. simplex (Walcott)	X					II, 43
24	M. tenuiramosus (Walcott)	X					II, 43
25	M. gracillimus (Lesquereux)			X	X		II, 43
26	M. laevis (Hall)			X	X		II, 45
27	Corynoides ultimus Rued	X					II, 47
28	Inocaulis arborescens Rued			X			II, 48
29	Leptogr. annectans (Walcott)						II, 50
	typus	X					II, 51
30	var. resupinus Rued	X					II, 51
31	var. patens Rued	X					II, 51
32	var. amplectens Rued	X					II, 51

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[1] Dr F. H. Knowlton has kindly informed me that the generic term Delesserites proposed by the writer in Part 2 (Bulletin 262, p. 8) for a seaweed from the upper Utica is preoccupied by a name given by Brongniart in 1828. I therefore propose to change the term to *Delesserella*.

List of Species and Varieties of Utica and Lorraine Formations of New York (continued)

Abbreviations: D. R.= Deer River shale. At = Atwater Creek shale. Col.= Collingwood shale. L = Lorraine beds in general. I = Part I (Bulletin 258), II = Part II (Bulletin 262), III = Part III (Bulletin 272).

NO.	NAME	Utica shale	Indian Ladder shale	Frankfort shale	Whetstone Gulf shale	Pulaski shale	References (page)
	Graptolitoidea (continued)						
33	Leptogr. flaccidus (Hall)	X					II, 52
34	Pleurogr. linearis (Carruthers)	X					II, 53
35	Dicranogr. nicholsoni Hopkinson	X	X				II, 53
36	Diplogr. amplexicaulis Hall mut. uticanus Rued	X					II, 54
37	Diplogr. (Orthogr.) nexus Rued				X		II, 55
38	Diplogr. recurrens Rued					X	II, 58
39	Climacogr. typicalis Hall	X		X	X		II, 59
40	Climacogr. typicalis posterus Rued	D R At			X		II, 60
41	C. tenuis Rued	X					II, 63
42	C. pygmaeus Rued	X					II, 63
43	C. lorrainensis Rued				X	X	II, 63
44	Glossogr. quadrimucronatus (Hall) typus	At					II, 64
45	approximatus Rued	X					II, 65
46	inequispinosus Rued	X					II, 66
47	lorrainensis Rued				X		II, 68
48	Lasiogr. (Thysanogr.) eucharis (Hall)	X					II, 68
	Crinoidea						
49	Ectenocrinus simplex (Hall)				X		II, 68
50	Heterocr. heterodactylus Hall				X		II, 69
51	H. difficilis Ulrich MS				X		II, 70
52	Iocrinus cf. subcrassus (M. & W.)				X		II, 70
	Vermes						
53	Spirorbis philorthoceras Rued	X					II, 72
54	Serpulites crassimarginalis Rued			X			II, 74
55	S. angustifolius (Hall)	X					II, 74
56	S. gracilis Rued			X			II, 74
57	S. lorrainensis Rued				X		II, 75
58	S. intermedius Rued			X			II, 75
59	Protoscolex cf. covingtonensis Ulrich			X			II, 76
60	P. giganteus Rued			X			II, 77
61	Cornulites immaturus Hall	X					II, 78
62	C. progressus Rued					X	II, 78
63	Arthraria magna Rued				X		II, 81
64	Arthrariella lorrainensis Rued				X		II, 83
65	Lonchosaccus uticanus Rued	X					II, 84
	Asteroidea						
66	Mesopalaeaster (?) lanceolatus Schuchert			X			II, 86

List of Species and Varieties of Utica and Lorraine Formations of New York (continued)

Abbreviations: D. R.= Deer River shale. At = Atwater Creek shale. Col.= Collingwood shale. L = Lorraine beds in general. I = Part I (Bulletin 258), II = Part II (Bulletin 262), III = Part III (Bulletin 272).

NO.	NAME	Utica shale	Indian Ladder shale	Frankfort shale	Whetstone Gulf shale	Pulaski shale	References (page)
	Bryozoa						
67	Stomatopora arachnoidea Hall				X	X	II, 86
68	Corynotrypa inflata Hall				X		II, 87
69	C. delicatula (James)				X	X	II, 88
70	Proboscina sp. cf. frondosa Nicholson				X		II, 89
71	Spatiopora lineata Ulrich						II, 89
72	var. crassipuncta Rued	X					II, 90
	var. compacta Rued	X					II, 90
73	Aspidopora bellula Ulrich & B. MS				X		II, 90
74	A. sp. nov. aff. spinulosa Ulr. MS.					X	I, 116 II, 91
75	Prasopora cf. contigua Ulr	X					II, 91
76	Peronopora cf. compressa (Ulr)					X	II, 92
77	Dekayella ulrichi (Nicholson)				X		II, 92
78	Stigmatella irregularis Ulr				X	X	II, 92
79	S. subsphaerica Rued				X		II, 92
80	S. pulaskiensis Rued					X	II, 94
81	S. sp. nov				X		II, 95
82	Atactopora hirsuta (Ulr.)					X	II, 95
83	A. maculata (Ulr.)					X	II, 96
84	Leptotrypa minima (Ulr.)					X	II, 96
85	Bythopora arctipora (Ulr.)				X	X	II, 96
86	B. gracilis (Nicholson)				X	X	II, 97
87	B. dendrina (James)					X	II, 97
88	Eridotrypa sp. aff. minor Ulr. MS.					X	I, 116
89	Amplexopora (?) discoidea (Nich.)				X	X	II, 98
90	A. persimilis Nickles				X		II, 98
91	A. cf. petasiformis (Nicholson)				X		II, 99
92	Hallopora onealli (James)		X		X		II, 99
93	Hallopora onealli (James) var. sigillarioides (Nich.)				X		II, 100
94	H. andrewsi (Nicholson)					X	II, 101
95	Hemiphragma bassleri Rued	X					II, 101
96	Arthrostylus tenuis (James)		X	X			II, 102
97	Arthropora cincinnatiensis (James)				X	X	II, 102
98	A. shafferi (Meek)				X	X	II, 103
99	A. clevelandi (James)				X		II, 103
100	Escharopora pavonia (M. E. & H.)				X	X	II, 104
101	Rhinidictya cf. parallela (James)		X				II, 105
102	Paleschara beani (James)				X		II, 105

List of Species and Varieties of Utica and Lorraine Formations of New York (continued)

Abbreviations: D. R.= Deer River shale. At = Atwater Creek shale. Col.= Collingwood shale. L = Lorraine beds in general. I = Part I (Bulletin 258), II = Part II (Bulletin 262), III = Part III (Bulletin 272).

NO.	NAME	Utica shale	Indian Ladder shale	Frankfort shale	Whetstone Gulf shale	Pulaski shale	References (page)
	Brachiopoda						
103	Leptobolus insignis (Hall)	X			X		II, 106
104	var. latus Rued			X			II, 107
105	Lingula sp					X	II, 108
106	L. curta Conrad	X					II, 171
107	L. bisulcata Ulrich				X		II, 108
108	L. (Pseudoling.) rectilateralis Emmons				X		II, 109
109	L. progne Billings	X		X			II, 110
110	L. cf. procteri Ulrich				X		II, 111
111	Trematis millepunctata Hall				X		II, 111
112	T. crassipunctata Ulrich					X	II, 112
113	T. sp. cf. dyeri Miller			X			II, 112
114	Schizocrania filosa (Hall)	X		X		X	II, 112
115	Schizambon minutus Rued	X					II, 113
116	Orbiculoidea tenuistriata Ulrich			X			II, 114
117	Crania laelia (Hall)				X	X	II, 114
118	Pholidops subtruncata (Hall)					X	II, 115
119	P. cincinnatiensis Hall				X		II, 116
120	Dalmanella cf. testudinaria Dalman	X			X	X	II, 116
121	D. multisecta (Meek)				X		II, 117
122	D. fultonensis Foerste lorrainensis Rued				X		II, 119
123	D. fultonensis rotunda Rued				X		II, 120
124	D. cf. emacerata Hall				X		II, 118
125	Hebertella occidentalis (Hall)					X	II, 120
126	Platystrophia uniplicata McEwan uticana Rued.	X					II, 120
127	Glyptorthis crispata Emmons				X	X	II, 121
128	Dinorthis pectinella (Emmons)			X			I, 54
129	Plectambonites sericeus (Sowerby)				X		II, 123
130	P. centricarinatus Rued		X				II, 123
131	P. plicatellus Ulrich		X				II, 123
132	P. rugosus (Meek)				X	X	II, 123
133	Rafinesquina alternata (Emmons)				X	X	II, 126
134	Rafinesquina nasuta (Conrad)					X	II, 126
135	centristriata Rued[1]				X		II, 127
136	Rafinesquina alternistriata (Hall)					X	II, 128
137	R. ulrichi (James)		X		X		II, 128
138	R. mucronata Foerste					X	II, 129

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[1] Erroneously cited as R. alternata centrilineata in part 1.

List of Species and Varieties of Utica and Lorraine Formations of New York (continued)

Abbreviations: D. R.= Deer River shale. At = Atwater Creek shale. Col.= Collingwood shale. L = Lorraine beds in general. I = Part I (Bulletin 258), II = Part II (Bulletin 262), III = Part III (Bulletin 272).

NO.	NAME	Utica shale	Indian Ladder shale	Frankfort shale	Whetstone Gulf shale	Pulaski shale	References (page)
139	Strophomena cf. planumbona (Hall)					X	II, 129
140	Leptaena richmondensis Foerste					X	II, 130
141	Orthorhynchula linneyi (James)	X					II, 131
142	Camarotoechia (?) humilis Rued.	X (top)		X			II, 132
143	Zygospira modesta (Say)				X	X	II, 133
144	Z. concentrica Ulrich				X		II, 134
145	Z. cincinnatiensis Meek				X		II, 134
146	Z. (?) erratica (Hall)					X	II, 135
	Pelecypoda						
147	Cuneamya subquadrangularis Rued	X					III, 6
148	C. ovata Rued. MS					X	I, 104, 109
149	C. sp. aff. neglecta Meek				X		III, 7
150	C. scapha H. & W. brevior Foerste					X	III, 9
151	C. elliptica Miller					X	III, 8
152	C. parva Miller				X		I,[1] 119
153	Ctenodonta nuculiformis (Hall)	X					III 10
154	C. pectunculoides (Hall)	(At)			X		III 11
155	C. lorrainensis Foerste					X	III 12
156	C. filistriata Ulrich				X		III 14
157	C. perminuta Ulrich				X		III 15
158	Clidophorus planulatus (Conrad)					X	III 16
159	C. scitulus (Emmons)				X		III 19
160	Ischyrodonta unionoides (Meek)					X	III 19
161	Whitella goniumbonata Foerste					X	III 22
162	Pterinea insueta (Emmons)	X			X		III 23
163	mut. bursa Rued.	(At) D. R.					III, 23
164	P. (Caritodens) demissa (Conrad)					X	III, 23
165	P. obtusiformis Ulr. MS				X		III, 26
166	P. sp. I				X		I, 91, 94, 99
167	Byssonychia radiata (Hall)					X	III, 27
168	B. vera Ulrich				X		III, 29
169	var. pluricosta Rued				X		III, 30
170	B. praecursa Ulrich					X	III, 30
171	B. hyacinthensis Foerste				X		III, 31
172	Psilonychia sp					X	I, 104
173	Modiodesma modiolare (Conrad)					X	III, 32
174	var. angustifrons (Conrad)					X	III, 34
175	var. brevius Ulrich					X	III, 34

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[1] Erroneously printed Cymatonota.

List of Species and Varieties of Utica and Lorraine Formations of New York (continued)

Abbreviations: D. R. = Deer River shale. At = Atwater Creek shale. Col. = Collingwood shale. L = Lorraine beds in general. I = Part I (Bulletin 258), II = Part II (Bulletin 262), III = Part III (Bulletin 272).

NO.	NAME	Utica shale	Indian Ladder shale	Frankfort shale	Whetstone Gulf shale	Pulaski shale	References (page)
176	Modiolopsis ovata (Conrad)[1]					X	III, 34
177	M. lorrainensis Ulrich MS					X	I, 116
178	M. anodontoides (Hall)					X	III, 35
179	Modiolodon obtusus Rued. MS					X	I, 121
180	Prolobella corrugata Rued				X		III, 38
181	Orthodesma pulaskiense Foerste					X	III, 38
182	O. sp. nov					X	I, 104
183	O. transitum Ulrich MS					X	I, 121
184	O. cf. corryvillense Ulrich					X	I, 121
185	O. cf. extensum Ulrich MS					X	I, 121
186	O. posteroquadratum Rued. MS				X		I, 107
187	Colpomya faba (E). pusilla Foerste					X	III, 40
188	Colpomya intermedia Rued				X		III, 41
189	Whiteavesia nasuta (Conrad)					X	III, 42
190	W. subplana Rued. MS				X		I, 94
191	W. foerstei Rued. MS				X		I, 94
192	W. (?) perstriata Rued. MS	X					I, 37
193	W. sp. nov					X	I, 121
194	Pholadomorpha pholadiformis (Hall)					X	III, 44
195	P. nasuta Ulrich MS					X	III, 45
196	Cymatonota parallela (Hall)					X	III, 46
197	var. intermedia Rued				X		III, 48
198	C. pholadis (Conrad)					X	III, 46
199	C. (?) (Orthodesma) prolatum Foerste					X	I, 121
200	C. sp. nov				X		I, 107
201	Psiloconcha subovalis Ulr					X	III, 49
202	P. acclivis Ulr. MS					X	I, 121
203	P. sinuata Ulrich					X	III, 49
204	Rhytimya radiata Ulrich				X		III, 50
205	R. compressa Ulrich					X	III, 50
206	R. producta Ulrich				X		III, 51
207	R. plana Rued[2]					X	III, 51
208	R. cancellata Walcott	X		X			III, 52
209	R. obesa Rued. MS					X	III, 53
210	R. sp					X	III, 54
211	Lyrodesma planum Conrad					X	III, 54
212	L. conradi Ulrich				X		III, 55
213	L. poststriatum (Emmons)					X	III, 56
214	L. cincinnatiense Hall					X	III, 57

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[1] Cited as M. praecedens Rued. MS. in part 1, p. 114.

[2] Wrongly cited in part 1, p. 109, as Psiloconcha subovalis.

List of Species and Varieties of Utica and Lorraine Formations of New York (continued)

Abbreviations: D. R. = Deer River shale. At = Atwater Creek shale. Col. = Collingwood shale. L = Lorraine beds in general. I = Part I (Bulletin 258), II = Part II (Bulletin 262), III = Part III (Bulletin 272).

NO.	NAME	Utica shale	Indian Ladder shale}	Frankfort shale	Whetstone Gulf shale	Pulaski shale	References (page)
	Gasteropoda						
215	Archinacella subcarinata Rued				X	X (base)	III, 58
216	A. pulaskiensis Foerste					X	III, 59
217	Cyrtolites ornatus (Conrad)					X	III, 60
218	Sinuites planodorsatus (Ulr.)				X		III, 61
219	S. cancellatus (Hall)					X	III, 62
220	S. granistriatus (Ulrich)				X		III, 63
221	Tetranota rugosa (Emmons)				X		III, 63
222	Lophospira bowdeni (Safford)					X	III, 64
223	L. cf. bicincta (Hall)					X	III, 65
224	L. abbreviata (Hall)				X	X	III, 65
225	L. lirata Ulrich				X		III, 67
226	Hormotoma gracilis (Hall) sublaxa Ulr. & Sc.				X	X	III, 67
227	H. salteri Ulr					X	III, 68
228	Liospira micula (Hall)				X	X	III, 69
229	L. vitruvia (Billings)				X		III, 70
230	L. cf. americana (Billings)				X		I, 120
231	Seelya sp. nov				X		III, 70
232	Plethospira quadricarinata Rued				X		III, 71
233	Eotomaria sp. cf. canalifera (Ulr.)				X		III, 72
234	E. pagoda. nov [1]					X	III, 72
235	Clathrospira subconica (Hall)				X	X	III, 73
236	C. conica Ulr. & Sc					X	III, 73
237	Eccyliomphalus trentonensis (Conr.) fimbriatus Rued				X		III, 74
238	E. sp				X		I, 91
239	Trochonema (Eunema) nitidum Ulr.				X		III, 74
240	Strophostylus gregarius Rued	X		X			III, 75
241	Holopea varicosa Rued	X					III, 76
242	Cyclora minuta Hall					X	III, 77
243	C. parvula Hall					X	III, 77
244	C. cf. pulcella Miller					X	III, 77
245	Hyolithes pumilus Rued				X		III, 77
246	Conularia hudsoni Emmons					?X	III, 78
247	C. granulata Hall	X					III, 80
248	C. papillata Hall	X					I, 37
	Cephalopoda						
249	Endoceras cf. proteiforme (Hall)	X					III, 80
250	E. lorrainense Rued					X	III, 81
251	E. romanum Rued					X	III, 84
252	E. (?) coralliferum (Hall) Rued	X					III, 84

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[1] Erroneously cited as Lophospira tropidophora (Meek) in part I.

List of Species and Varieties of Utica and Lorraine Formations of New York (continued)

Abbreviations: D. R.= Deer River shale. At = Atwater Creek shale. Col.= Collingwood shale. L = Lorraine beds in general. I = Part I (Bulletin 258), II = Part II (Bulletin 262), III = Part III (Bulletin 272).

NO.	NAME	Utica shale	Indian Ladder shale	Frankfort shale	Whetstone Gulf shale	Pulaski shale	References (page)
253	E. perannualatum Rued	X					III, 86
254	Orthoceras (?) cf. transversum Miller				X		III, 87
255	Geisonoceras tenuistriatum (Hall)	X					III, 88
256	var. frankfortense Rued	(At) D. R.		X			III, 89
257	G. amplicameratum (Hall)	X					III, 90
258	G. sp. ind.	X					III, 92
259	Cycloceras persculptum Rued	X					III, 92
260	Spyroceras bilineatum (Hall)	X					III, 92
261	Protokionoceras oneidaense (Walcott)	X					III 93
262	Trocholites ammonius (Conrad) Trocholites ammonius major Rued	X					III, 94
263	Trocholites angustiumbilicatus Rued	X					III, 97
264	T. planorbiformis (Conrad)					X	III, 98
265	Actinoceras crebriseptum (Hall)					X	III, 100
266	Paractinoceras lamellosum (Hall)				X	X	III, 102
267	P. (?) pusillum Rued					X	III, 103
268	Oncoceras pupaeforme Rued	X					III, 104
	Trilobita						
269	Cryptolithus cf. tesselatus Green				X		I, 105
270	C. bellulus Ulrich		X	X	X		III, 106
271	C. lorrainensis Rued					X	III, 107
272	Triarthrus eatoni (Hall) Rued	X (At)		X	X		III, 119
273	T. spinosus Billings	X					III, 121
274	T. huguiensis Foerste				X		III, 123
275	Ogygites latimarginatus (Hall)	X					III, 124
276	Homotelus stegops (Green)	Col. X			X		III, 126
277	Isotelus pulaskiensis Ulr. MS.					X	III, 128
278	I. spurlocki (Meek)				X		I, 94
279	Gerasaphes ulrichana Clarke				X		I, 120
280	Proetus beecheri Rued			X			III, 128
281	Odontopleura crosota (Locke)			X	X		III, 130
282	O. ceralepta (Anthony)				X		III, 131
283	Calymene meeki Foerste				X	X	III, 136
284	C. granulosa Foerste					X	III, 136
285	Pterygometopus cf. callicephalus (Hall)		X				III, 137
286	Aparchites minutissimus (Hall)	X		X	X	X	III, 138

List of Species and Varieties of Utica and Lorraine Formations of New York (concluded)

Abbreviations: D. R. = Deer River shale. At = Atwater Creek shale. Col. = Collingwood shale. L = Lorraine beds in general. I = Part I (Bulletin 258), II = Part II (Bulletin 262), III = Part III (Bulletin 272).

NO.	NAME	Utica shale	Indian Ladder shale	Frankfort shale	Whetstone Gulf shale	Pulaski shale	References (page)
287	Primitiella unicornis (Ulr.)				X		III, 137
288	Primitia centralis (Ulr.)				X		III, 138
289	P. rudis (Ulr.)			X	X		III, 139
290	P. sp. cf. cincinnatiensis (Miller)				X		I, 93
291	Jonesella pedigera (Ulr.)				X		III, 140
292	Bollia uticana Rued	X					III, 140
293	B. pulchra Rued				X		III, 141
294	B. sp. aff. pulchra Rued	X					III, 142
295	Ceratopsis oculifera (Hall)					X	III, 143
296	C. chambersi (Miller)		X				III, 143
297	Dilobella lorrainensis Rued				X		III, 142
298	Bythocypris cylindrica (Hall)				X	X	III, 144
299	Elpe radiata Ulrich	(D.R.)			X		III, 144
	Cirripedia						
300	Lepidocoleus jamesi (H. & W.)		X		X	X	III, 145
301	Eobalanus informans Rued	X					III, 146
302	Eopollicipes sp.				X		I, 94
	Phyllocarida						
303	Ceratiocaris (Limnocaris) timida Rued	X					III, 147
304	C. sp.			X			III, 148
	Merostomata						
305	Echinognathus clevelandi Walcott	X					III, 149
306	Stylonurus sp.				X		III, 150
307	Eurypterus (?) rusti Rued	X					III, 150
308	Dolichopteru insolitus Rued	X					III, 151
309	Eusarcus breviceps Rued	X					III, 153
310	Hughmilleria uticana Rued	X					III, 153
311	Pterygotus walcotti Rued	X					III, 154

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EXPLANATION OF PLATES

Plate 1

Cuneamya subquadrangularis nov.

Page 6

Figures 1 and 2 Holotype. Mold and natural cast. Natural size. Upper Utica shale. Holland Patent, N. Y.

Cuneamya aff. **neglecta** (Meek)

Page 7

Figure 3 Hall's type of **Modiolopsis anodontoides** (Palaeontology of New York, volume 1, plate 82, figure 3). Flattened specimen x2. Whetstone Gulf shale, Rodman, Jefferson county, N. Y.

Figure 4 Large specimen. Natural size; from squeeze. Pulaski shale, Worthville, N. Y.

Cuneamya elliptica Miller

Page 8

Figure 5 Somewhat flattened specimen. Natural size. Pulaski shale, Worthville, N. Y.

Cuneamya scapha H. & W.
cf. mut. **brevior** Foerste

Page 9

Figure 6 Specimen slightly compressed obliquely. Natural size. Pulaski shale, Lorraine, N. Y.

Figure 7 Another specimen, folded upon itself, retaining hinge-line. Natural size. Pulaski shale, Lorraine, N. Y.

Ctenodonta pectunculoides (Hall)

Page 11

Figure 8 Two valves of one individual, x2. Whetstone Gulf shale, station 9 of Whetstone gulf section.

Figure 9 Valve showing well the cardinal margins and growth lines, x3. Whetstone Gulf shale, station 9 of Whetstone gulf section.

Figure 10 Average specimen, x2. From station 10 to 11 of Whetstone gulf section.

Figure 11 Specimen in which the cardinal teeth are seen, x2. Pulaski shale, Worthville, N. Y.

Figure 12 Hinge, x5. Lorraine beds (Whetstone Gulf shale). Near Rome, N. Y.

Ctenodonta filistriata Ulrich

Page 14

Figure 13 Characteristic specimen. Natural size. Whetstone Gulf shale, station 1 of Wood creek section, near Rome, N. Y.

Figure 14 Series of specimens showing somewhat different outlines. Natural size. From Whetstone Gulf shale, near Rome, N. Y.

The originals of figures 1, 2 ~~and 15~~ are in the United States National Museum; the others are in the New York State Museum.

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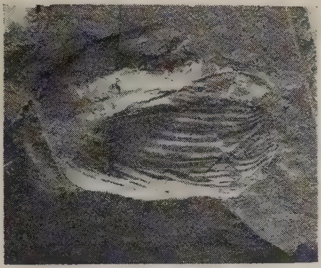

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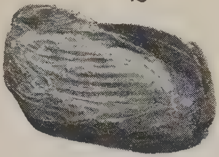

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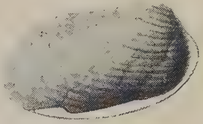

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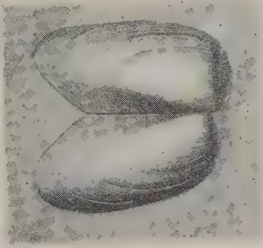

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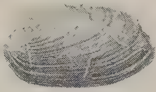

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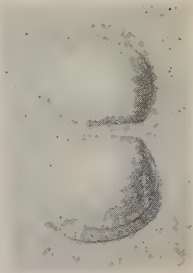

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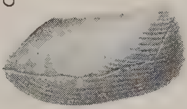

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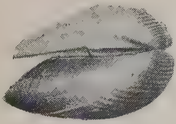

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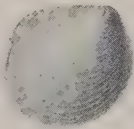

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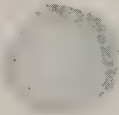

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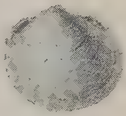

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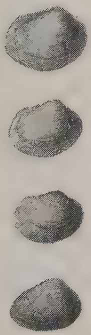

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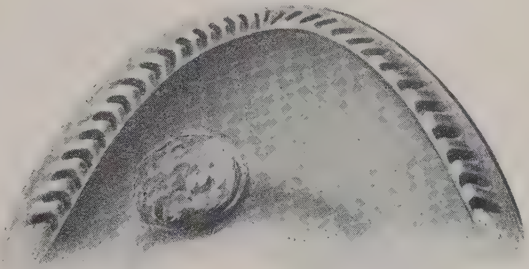

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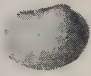

G. S. B. del. et E. S. photo.

Plate 2

Ischyrodonta unionoides (Meek)

Page 19

Figure 1 Typical specimen, right valve, showing muscle impressions (also pedal muscle) Natural size. Lorraine (Pulaski) drift, near Trenton, N. Y.

Figure 2 Left valve; shows muscle impressions and mantle line. Natural size. Lorraine (Pulaski) drift, near Trenton, N. Y.

Figure 3 Valve retaining more distinctly external features. Natural size. Lorraine (Pulaski) drift, near Trenton, N. Y.

Pterinea insueta (Emmons)

Page 23

Figure 4 Holotype of mutation **bursa.** Deer River shale, Whetstone gulf, Lewis county, N. Y.

Figure 5 Undescribed mutation of the species from the upper Utica shale at Holland Patent. Natural size.

Pterinea obtusiformis UlrichMS.

Page 26

Figure 6 A characteristic valve identified by Doctor Ulrich. Natural size. Whetstone Gulf shale, Wood creek section, station 1.

Pterinea (Caritodens) demissa Conrad

Page 23

Figures 7 and 8 Left valves, showing the muscle scars. Natural size. Lorraine (Pulaski) drift, near Trenton, N. Y.

Figure 9 Younger individual, showing different outline, surface sculpture, muscle scars and pallial line. Natural size. Lorraine (Pulaski) drift from towns of Trenton and Russia, N. Y.

Figure 10 Type of Emmons' figure (2d Dist Rep't, 1842, fig. 113). Natural size. Lorraine beds, Jefferson county, N. Y.

Figure 11 A broader valve showing well the growth lines; from squeeze. Natural size. Lorraine (Pulaski) drift near Trenton, N. Y.

The originals of the figures are in the New York State Museum.

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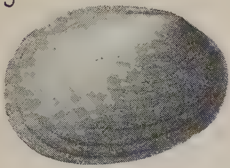

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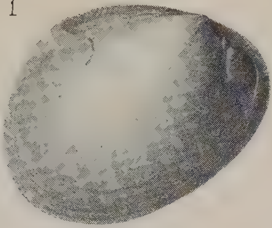

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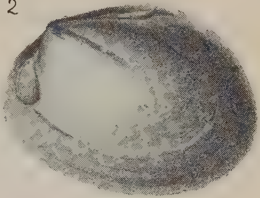

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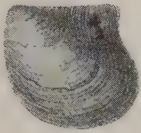

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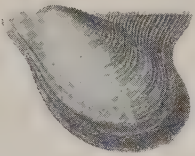

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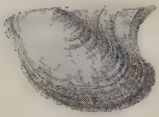

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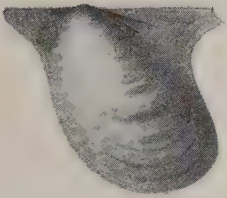

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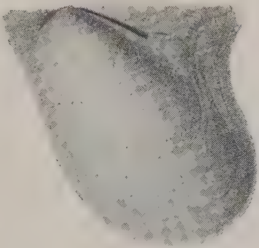

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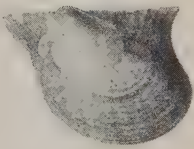

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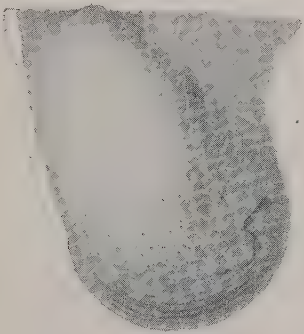

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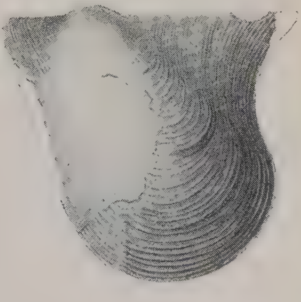

G. S. Barkentin del.

Plate 3

Byssonychia radiata (Hall)[1]

Page 27

Figure 1 Right valve, natural size, showing strong posterior lateral teeth, posterior adductor muscle and pallial lines.

Figures 2 and 3 Rostral portions of the left and right valves, x5, showing the cardinal teeth.

All specimens are from the Lorraine (Pulaski) drift near Trenton, N. Y.

Byssonychia vera Ulrich

Page 29

Figure 4 Large typical left valve identified by Doctor Ulrich. Natural size. Whetstone Gulf shale, station 15 of Lorraine gulf section.

Figure 5 Right valve with 55 ribs. Natural size. Whetstone Gulf shale, station 18 of Lorraine gulf section.

Figure 6 Hinge-line of specimen with 56 ribs. Natural size.

Figure 7 Smaller left valve with 55 ribs. Natural size. Whetstone Gulf shale, station 11 of Whetstone Gulf section.

Byssonychia vera Ulrich
var. **pluricosta** nov.

Page 30

Figure 8 Type specimen, natural size, with 65 ribs. Whetstone Gulf shale, station 3 of Wood Creek section.

Byssonychia hyacinthensis Foerste

Page 31

Figure 9 Right valve. Natural size. Whetstone Gulf shale, station 11 of Whetstone gulf section.

Prolobella corrugata nov.

Page 38

Figure 10 Paratype x4. Whetstone Gulf formation near Rome, N. Y.

Figure 11 Type specimen (holotype) x4. Whetstone Gulf formation near Rome, N. Y.

Figure 12 A specimen from the Upper Utica shale at Holland Patent, x2.

The originals are in the New York State Museum.

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[1] See also Part I (N. Y. State Museum Bulletin 258) plate facing page 130

UTICA AND LORRAINE FOSSILS

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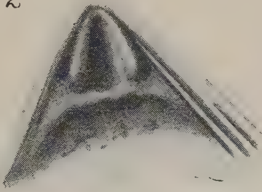

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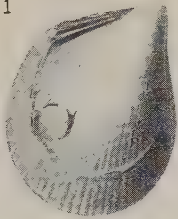

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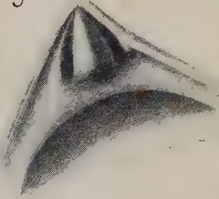

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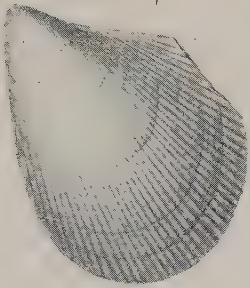

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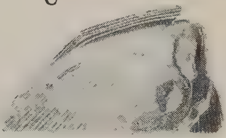

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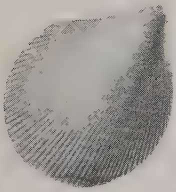

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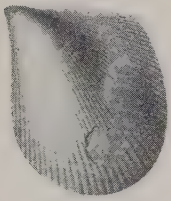

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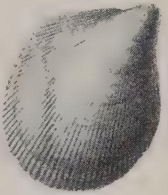

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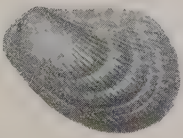

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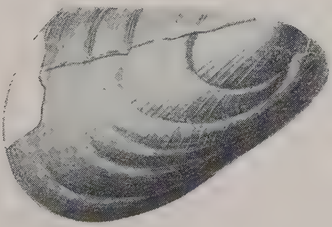

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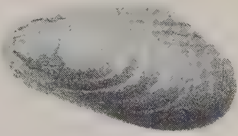

G. S. Barkentin del.

Plate 4

Figure 1 A typical Lorraine (Pulaski) slab with **Modiolopsis ovata** (Conrad) on the left, and **Modiodesma modiolare** (Conrad)[1] on the upper right. Natural size. Pulaski sandstone, Oswego county, N. Y.

The slab is on exhibition in the N. Y. State Museum.

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[1] See also part I (New York State Museum Bul. 258) plate facing page 130.

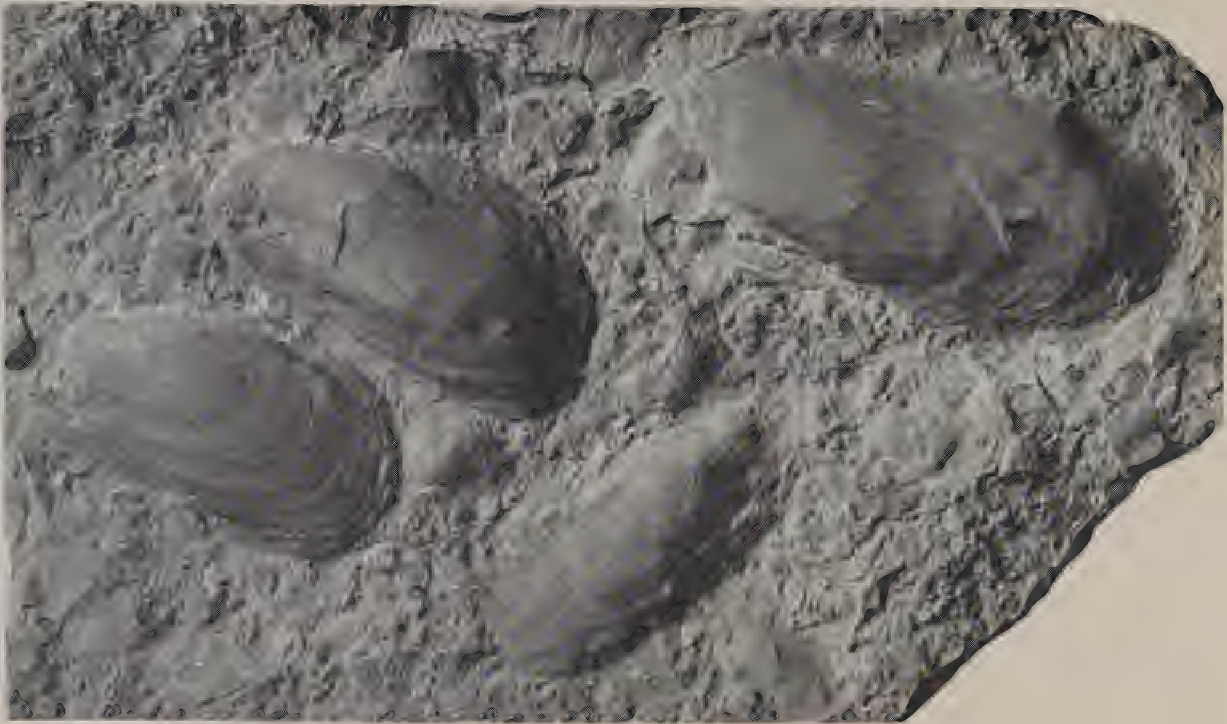

Plate 5

Modiolopsis anodontoides Hall

Page 35

Figure 1 Conrad's and Hall's type. Natural size. Lorraine (Pulaski) sandstone, Lorraine, N. Y.

Orthodesma pulaskiense Foerste

Page 38

Figure 2 Right valve. Natural size. Pulaski sandstone. Drift near Trenton, N. Y.

Whiteavesia nasuta (Conrad)

Page 42

Figures 3 and 4 Two left valves showing slightly different outlines and the muscle scars. Natural size. Pulaski sandstone. Talcott's quarry near Rome, N. Y.

Figures 5 and 6 Two left valves of characteristic outline and showing the surface sculpture as well as the muscle scars. Natural size. Pulaski sandstone. Drift near Trenton, N. Y.

Pholadomorpha nasuta Ulrich MS.

Page 45

Figure 7 Holotype. Natural size. Upper Pulaski sandstone, station 28, of Lorraine gulf section.

Figure 8 A larger specimen not typical and doubtfully referred here. Natural size. Upper Pulaski sandstone, station 28 of Lorraine gulf section.

Colpomya faba (Emmons) mut. **intermedia** nov.

Page 41

Figure 9 Holotype. x 2. Whetstone gulf shale, station 17 of Lorraine gulf section.

All the originals are in the New York State Museum.

UTICA AND LORRAINE FOSSILS

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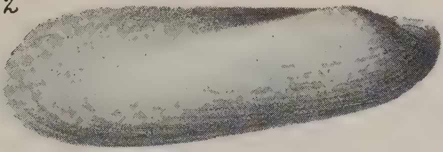

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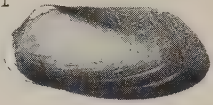

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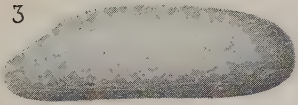

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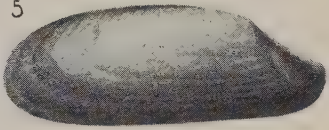

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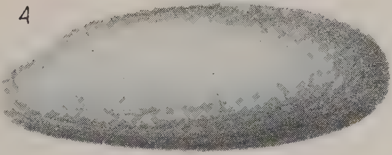

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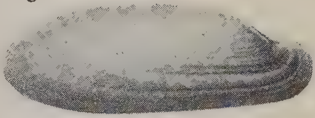

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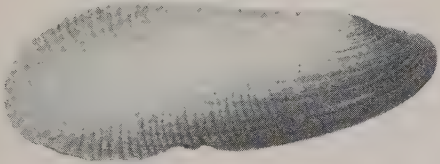

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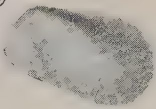

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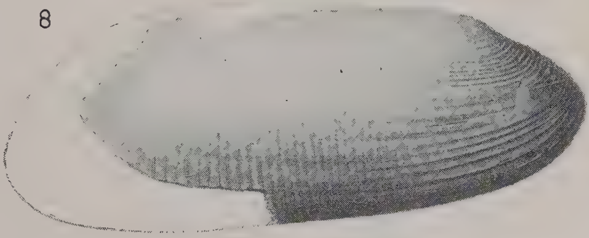

G. S. Barkentin del.

Plate 6

Cymatonota parallela (Hall)

Page 46

Figure 1 A compressed specimen corresponding in outline to **C. pholadis** (Conrad). Natural size. Pulaski sandstone. Drift near Trenton, N. Y.

Figure 2 A similar specimen from Pulaski sandstone at Martinsburg. Natural size.

Cymatonota parallela (Hall) mut. **intermedia** nov.

Page 48

Figure 3 Right valve of young individual, x2. From squeeze Whetstone Gulf formation near Rome, N. Y.

Figure 4 Right valve showing muscle scars. Natural size. Whetstone Gulf formation, near Rome, N. Y.

Figure 5 Left valve. Natural size. Whetstone Gulf shale, station 8 of Wood creek section.

Psiloconcha subovalis Ulrich

Page 49

Figure 6 Right valve. Natural size. Base of Pulaski beds. Station *22a* of Lorraine gulf section.

Rhytimya compressa Ulrich

Page 50

Figure 7 Right valve. Natural size. Base of Pulaski beds, station *22a* of Lorraine gulf section.

Figure 8 Surface sculpture, x5. Base of Pulaski beds, station *22a* of Lorraine gulf section.

Rhytimya radiata Ulrich

Page 50

Figure 9 Two typical valves. Natural size. Whetstone Gulf shale, station 7 of Whetstone gulf section.

Rhytimya producta Ulrich

Page 51

Figure 10 Right valve. Natural size. Pulaski sandstone of the Lorraine gorge.

Figure 11 Smaller complete right valve x3. Pulaski shale, station 14 of Whetstone Gulf section.

Rhytimya sp.

Page 54

Figure 12 Left valve of specimen; probably a new species. Natural size. Base of Pulaski beds, station *22a* of Lorraine Gulf section.

Rhytimya plana nov.

Page 51

Figure 13 Holotype. Natural size. Basal Pulaski beds, station *22a* of Lorraine Gulf section.

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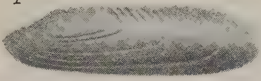

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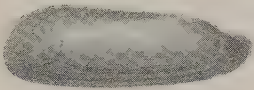

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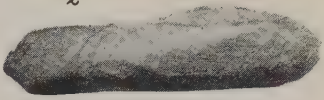

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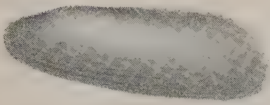

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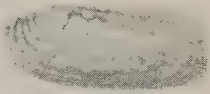

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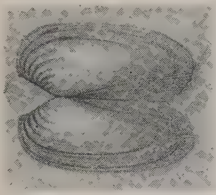

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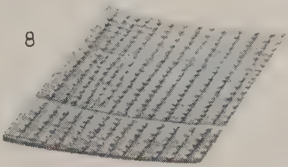

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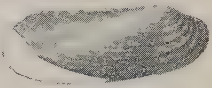

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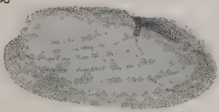

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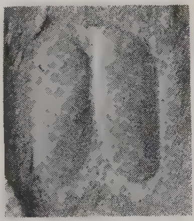

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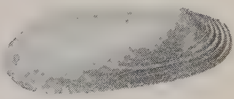

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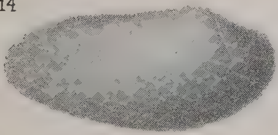

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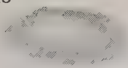

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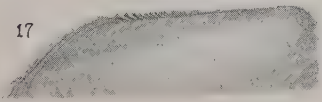

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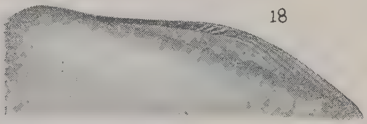

G. S. B. del. et E. S. photo.

Clidophorus scitulus Emmons

Page 19

Figures 14 and 15 Two right valves showing slightly different expressions, x2. Whetstone Gulf shale.

Original of figure 14 from station 17 of Lorraine gulf section; that of figure 15 from station 9 of the Wood creek section.

Figure 16 Characteristic specimen. Natural size. Whetstone Gulf shale, station 8 of Wood creek section.

Figures 17 and 18. Hinge-lines to show the posterior teeth of the right and left valves; figure 17, x4; figure 18, x5. Whetstone Gulf shale near Rome, N. Y.

All the originals are in the New York State Museum.

Plate 7

Lyrodesma conradi Ulrich

Page 55

Figure 1 Typical specimen, x2, to show the surface sculpture. Figured from squeeze. Whetstone Gulf shale, station 9 of Wood creek section.

Figure 2 Right valve. Natural size. Whetstone Gulf shale, station 8 of Wood creek section.

Figure 3 Right valve of young individual, x2. Whetstone Gulf shale, station 4 of Wood creek section.

Figure 4 Specimen with slightly different outline. Natural size. Whetstone Gulf shale, station 8 of Wood creek section.

Lyrodesma cf. **planum** Conrad

Page 54

Figure 5 Specimen probably referable to this species. Natural size. Pulaski beds, station 25 of Lorraine gulf section.

Figure 5*a* Enlargement (x5) of surface of same.

Lyrodesma poststriatum (Emmons) Hall

Page 56

Figures 6 and 7 Typical left and right valves. Natural size. From squeezes. Top of Pulaski sandstone at Pulaski, N. Y.

Figure 8 Cast of interior, showing two pairs of pedal muscles. Natural size.

Figure 9 Cast of interior, showing the adductor muscles and pallial line. Natural size.

Figure 10 Hinge x3.

The originals of figures 8 to 10 are from the Pulaski sandstone drift near Trenton, N. Y.

Lyrodesma cincinnatiense Hall

Page 57

Figures 11 and 12 Two right valves of characteristic expression, x2. Whetstone Gulf shale, station 21*a* of Lorraine gulf section.

Figure 13 Left valve showing anterior adductor muscle, x2. Whetstone Gulf shale, station 21*a* of Lorraine gulf section.

Figure 14 Case of interior of left valve, x2, showing impressions of teeth. Base of Pulaski beds, station 22*a* of Lorraine gulf section.

Figure 15 Enlargement (x5) of cast of rostral portion of the preceding.

Figure 16 Rostral portion enlarged, x3. From squeeze. Pulaski sandstone drift near Trenton, N. Y.

The originals of all specimens are in the N. Y. State Museum.

UTICA AND LORRAINE FOSSILS

Bulletin 272

Plate 7

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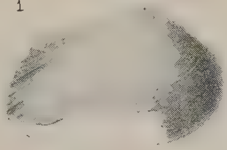

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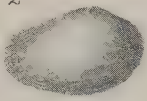

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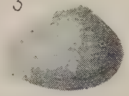

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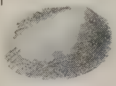

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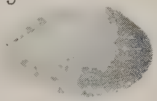

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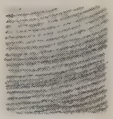

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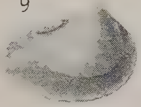

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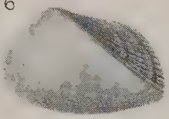

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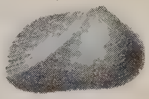

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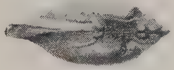

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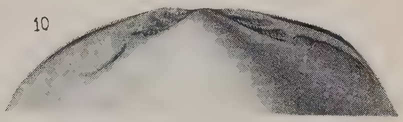

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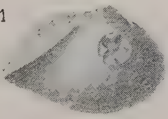

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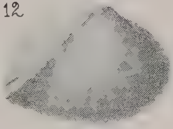

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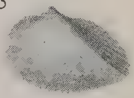

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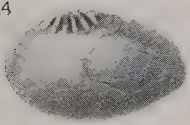

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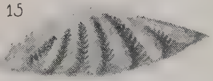

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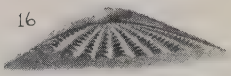

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Plate 8

Archinacella subcarinata nov.

Page 58

Figure 1 Paratype, x2. Slightly restored on right side. Whetstone Gulf shale, station 22 (locality 5066) of Lorraine gulf section.

Figure 2 Holotype, x2. Whetstone Gulf shale, station 9 of Wood creek section.

Cyrtolites ornatus (Conrad)

Page 60

Figure 3 A characteristic interior cast, the common occurrence in the Lorraine drift. Natural size. Drift near Trenton, N. Y.

Figure 4 Piece of Lorraine (Pulaski) drift exhibiting lateral and dorsal views of typical specimens. The former with aperture. Natural size. Lorraine (Pulaski) near Trenton, N. Y.

Sinuites planodorsatus (Ulrich)

Page 61

Figure 5 Dorsal view of typical specimen. Natural size. Whetstone Gulf shale, station 1 of Wood creek section.

Sinuites cancellatus (Hall)

Page 62

Figure 6 Lateral and dorsal views of two large specimens. Natural size. Pulaski beds near Pulaski, N. Y.

Sinuites granistriatus (Ulrich)

Page 63

Figure 7 Characteristic specimen compressed obliquely. Natural size.

Figure *7a* Enlargement of surface of same.

Figure 8 Specimen with well-preserved surface sculpture, x3. Whetstone Gulf shale, near Rome, N. Y.

Tetranota rugosa (Emmons)

Page 63

Figure 9 Dorsal view of specimen, x2. Whetstone Gulf shale, station 17 of Lorraine gulf section.

Lophospira bowdeni (Safford)

Page 64

Figure 10 Specimen figured in natural size; from squeeze. Pulaski beds at Pulaski, N. Y.

Lophospira abbreviata (Hall)

Page 65

Figure 11 Nearly complete specimen. Natural size. Pulaski drift, Pulaski, N. Y.

Figure 12 Enlargement (x3) of fragment of shell to show the character of the slit-band.

Figure 13 Typical specimen from Pulaski drift near Trenton Falls, N. Y. See also figure 4.

UTICA AND LORRAINE FOSSILS

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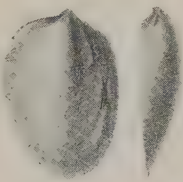

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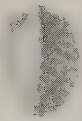

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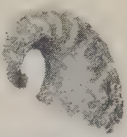

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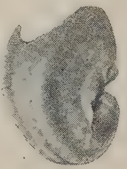

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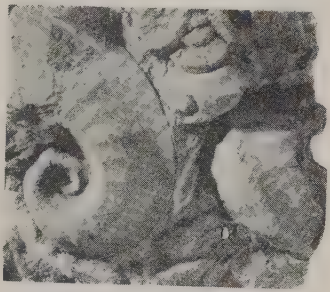

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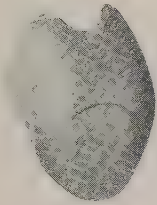

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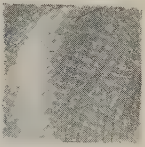

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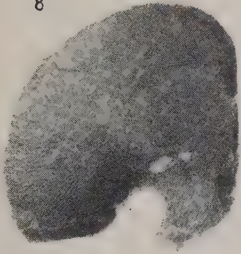

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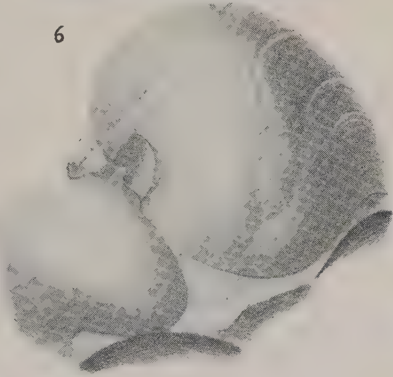

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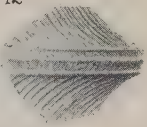

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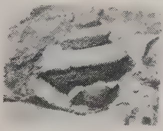

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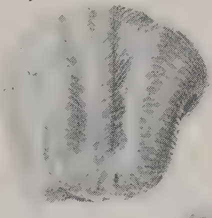

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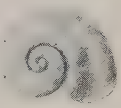

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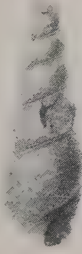

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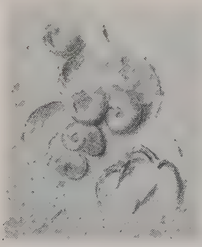

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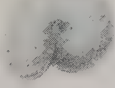

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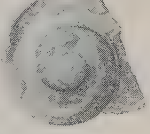


G. S. B. et E. K. B. del.; E. S. photo.

Hormotoma gracilis (Hall) var. **sublaxa** Ulrich & Scofield

Page 67

Figure 14 Average specimen in natural size. Pulaski beds, Lorraine Gorge, N. Y.

Liospira micula (Hall)

Page 69

Figure 15 Group of specimens. Natural size.

Figure 16 Top view of figure 15, x3.

Figure 17 Underside of another specimen, x4. Pulaski beds, Pulaski, N. Y.

Figure 18 Cast of interior of shell. A frequent occurrence in the Lorraine drift. Natural size. Drift near Trenton, N. Y.

Liospira vitruvia (Billings)

Page 70

Figure 19 Top view of specimen. Natural size. Whetstone gulf shale, station 10 of Wood creek section.

The originals of the figures are in the New York State Museum, with the exception of those of figures 3, 4, 11 and 13, which are in the United States National Museum.

Plate 9

Seelya sp.

Page 70

Figure 1 Fragmentary valve, x2. Whetstone Gulf shale, station 1 of Wood creek section.

Plethospira quadricarinata nov.

Page 71

Figure 2 Well preserved fragment of valve, showing the four carinations, x3. Holotype. Whetstone Gulf shale, near Rome, N. Y.

Figure 3 Underside of specimen, x2. Paratype. Whetstone Gulf shale, station 1 of Wood creek section.

Figure 4 Last volution. Natural size. Paratype. Whetstone Gulf shale, station 9 of Wood creek section.

Figure 5 Specimen retaining two volutions, x2. Paratype. Frankfort shale, 1½ miles east of Rome, N. Y.

Eotomaria pagoda nov.

Page 72

Figure 6 Holotype. Natural size.

Figure 7 Paratype. Natural size.

Figure 8 Paratype. Specimen retaining more perfect, last volution. Natural size. Pulaski drift, near Trenton, N. Y.

Clathrospira conica Ulrich & Scofield

Page 73

Figures 9 and 11 Two specimens of slightly different contours, showing aperture. Natural size. Pulaski beds at Pulaski, N. Y.

Figure 10 Specimen partly broken and showing the columella or axis. Natural size. Pulaski drift, near Trenton, N. Y.

Eccyliomphalus trentonensis (Conrad) mut. **fimbriatus** nov.

Page 74

Figure 12 Holotype. Natural size. Surface sculpture, x5. Whetstone Gulf shale, station 1 of Wood creek section.

Trochonema (Eunema) nitidum (Ulrich)

Page 74

Figure 13 Last whorl of a specimen. Natural size. Whetstone Gulf shale, near Rome, N. Y.

Figure 14 Compressed specimen. Natural size. From station 12 of Moose creek section.

Strophostylus gregarius nov.

Page 75

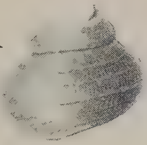
Figure 15 Group of type specimens, x5. Upper Utica shale. Holland Patent, N. Y.

Holopea varicosa nov.

Page 76

Figures 16 and 17 Holotype, x2, and natural size. Upper Utica shale, at Holland Patent, N. Y.

The originals are in the New York State Museum, except those of figures 5, 8, 15, 16 and 17, which are in the United States National Museum.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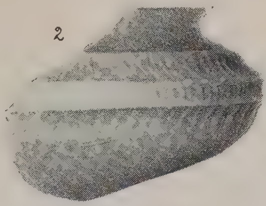
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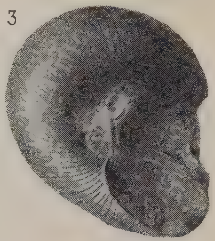
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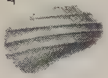
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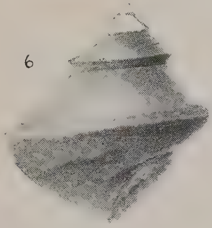
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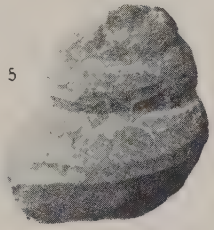
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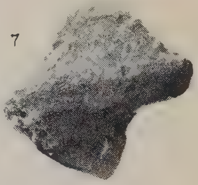
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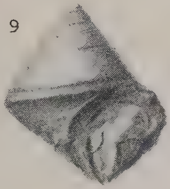
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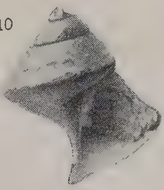
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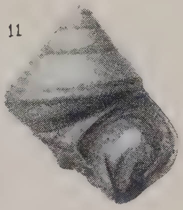
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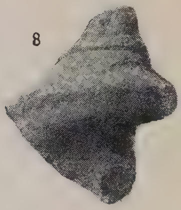
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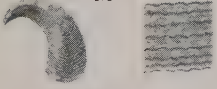
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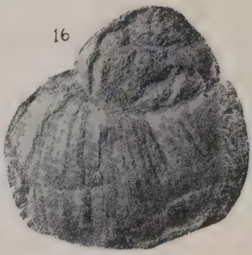
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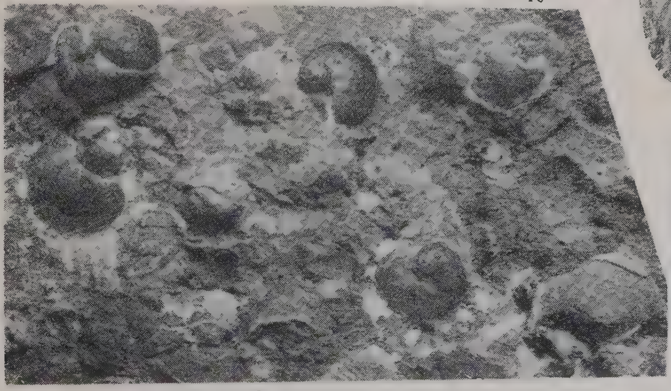
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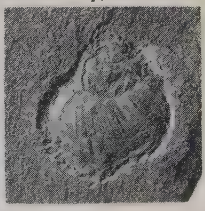
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G. S. B. et E. K. B. del.; E. S. photo.

Plate 10

Cyclora minuta Hall

Page 77

Figure 1 Specimen from Pulaski drift near Trenton, N. Y. x8.

Figure 2 Specimen from base of Pulaski beds, station 22a of Lorraine gulf section, x15.

Cyclora cf. **pulcella** ~~Hall~~ Miller

Page 77

Figure 3 Shell, x15. Pulaski beds, station *22a* of Lorraine gulf section.

Cyclora parvula Hall

Page 77

Figure 4 Specimen, x15. Pulaski beds, station 23 of the Lorraine gulf section.

Hyolithes pumilus nov.

Page 77

Figure 5 Holotype, x5. Whetstone Gulf shale, station 6 of Whetstone gulf section.

Figure 6 Paratype, x2. Whetstone Gulf shale, station 6 of Lorraine gulf section.

Conularia hudsoni Emmons

Page 78

Figure 7 Specimen from Pulaski beds at Pulaski. Natural size.

Figure 8 Surface sculpture, x5.

Conularia trentonensis Hall mut. **latior** Ruedemann

Page 79

Figure 9 Paratype, x2. Collingwood shale. Collingwood, Lake Huron, Canada.

Conularia granulata Hall

Page 80

Figure 10 Characteristic specimen, x3. Upper Utica shale, South Trenton, N. Y.

Protokionoceras oneidaense Walcott

(See plate 16, figure 1)

Page 93

Figure 11 Specimen from the Utica shale, Oneida county, N. Y. Natural size.

Geisonoceras tenuistriatum (Hall)

(See plate 11, figure 2)

Page 88

Figure 12 Compressed specimen showing the surface sculpture. Natural size. Upper Utica shale, Holland Patent, N. Y.

Figure 13 Section of specimen, x2, showing character of siphuncle. Canajoharie shale, Schoharie creek, near Fort Hunter, N. Y.

Figure 14 Uncompressed specimen showing rate of growth and sutures. Natural size. Upper Utica shale, Holland Patent, N. Y.

The originals are in the New York State Museum, except those of figures 9, 10 and 11, which are in the United States National Museum.

UTICA AND LORRAINE FOSSILS

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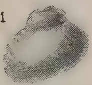

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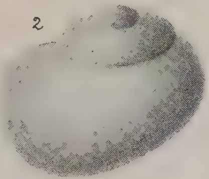

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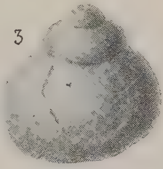

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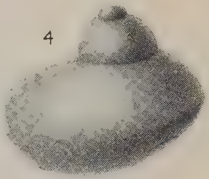

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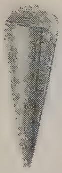

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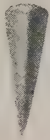

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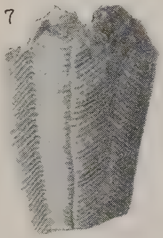

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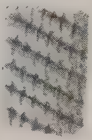

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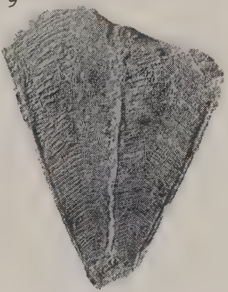

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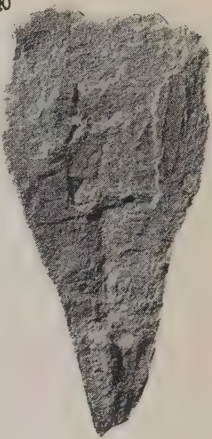

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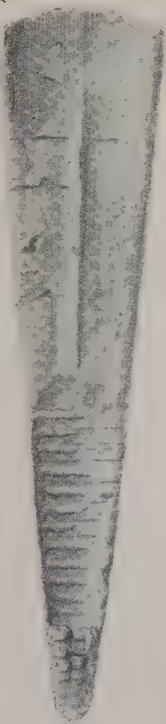

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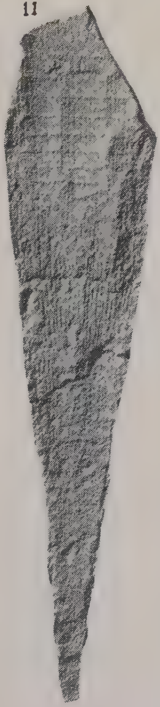

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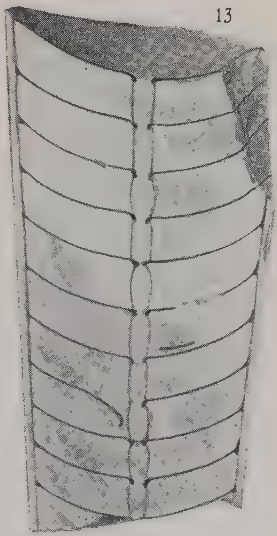

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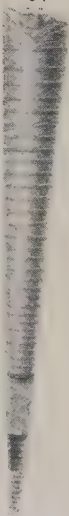

G. S. B. del.; E. S. et J. A. G. photo.

Plate 11

Geisonoceras amplicameratum (Hall)

(See plate 12, figures 2 and 3)

Page 90

Figure 1 Conch retaining living chamber and showing sutures and septa, the latter as shadows produced by the compression of the shell. Natural size. Upper Utica shale, Holland Patent, N. Y.

Geisonoceras tenuistriatum (Hall)

(See plate 10, figures 12–14)

Page 88

Figure 2 Compressed conch with living chamber and sutures. Natural size. Upper Utica shale, Holland Patent, N. Y.

The originals are in the N. Y. State Museum.

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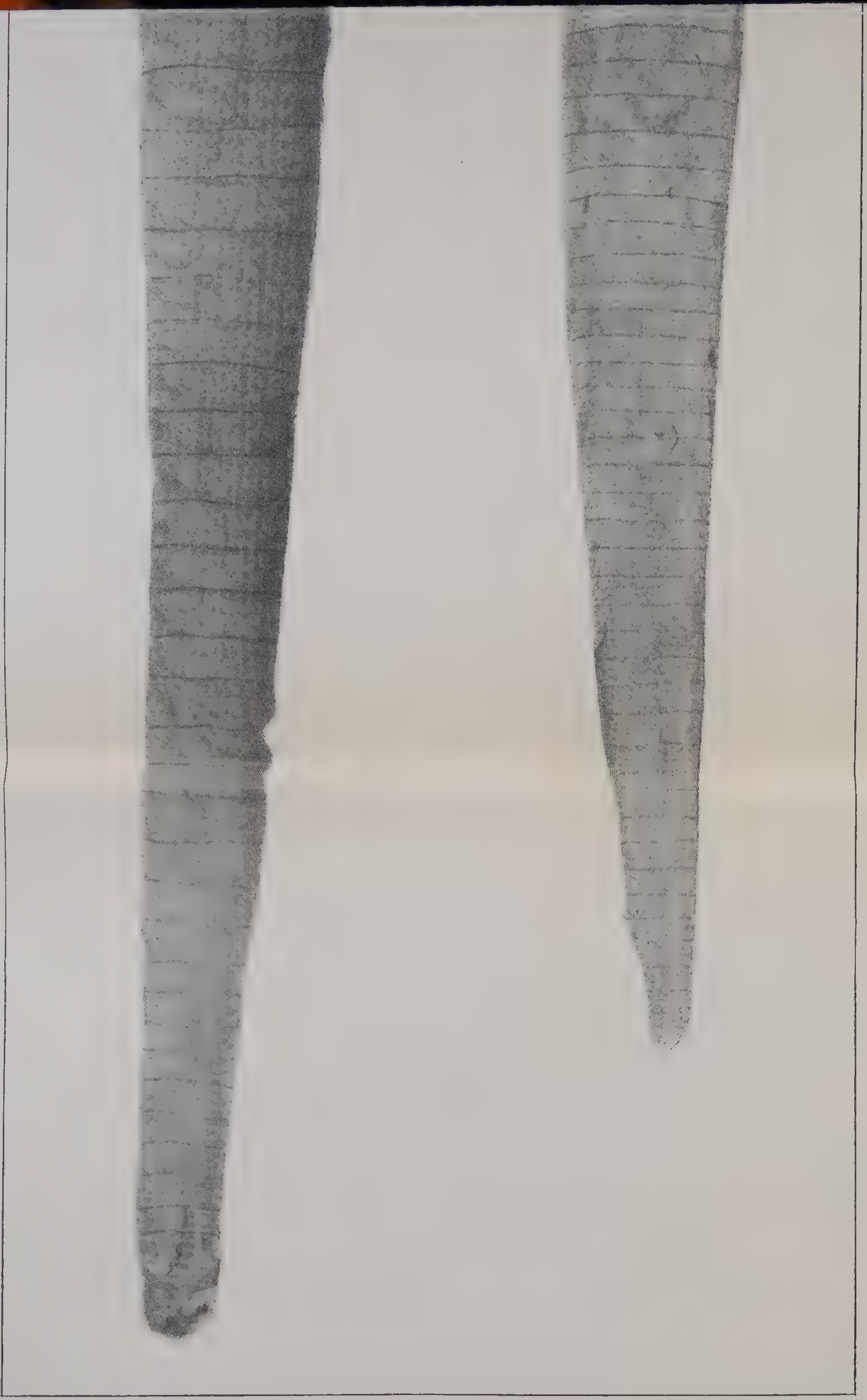

Angel De Cora del.

Plate 12

Geisonoceras tenuistriatum (Hall)

mut. **frankfortense** nov.

Page 89

Figure 1 Holotype showing curvature of shell, living chamber and septa. Natural size. Frankfort shale, Delta dam near Rome, N. Y.

Geisonoceras amplicameratum (Hall)

(See plate 11, figure 1)

Page 90

Figure 2 Complete living chamber and last camerae. Natural size.

Figure 3 Young conch, showing rate of growth and sutures. Natural size. Upper Utica shale, Holland Patent, N. Y.

Geisonoceras sp. nov.

Page 92

Figure 4 Compressed conch. Natural size.

Orthoceras cf. **transversum** Miller

Page 87

Figure 5 Fragment showing the sutures and surface sculpture. Natural size. Whetstone Gulf formation, station 1 of Wood creek section.

The originals are in the New York State Museum.

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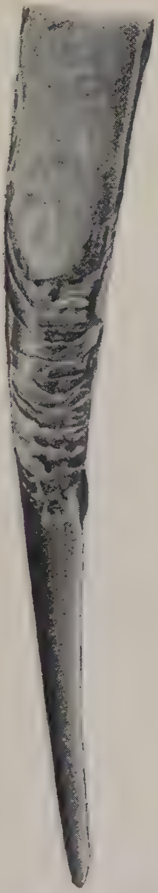

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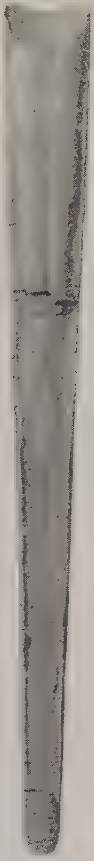

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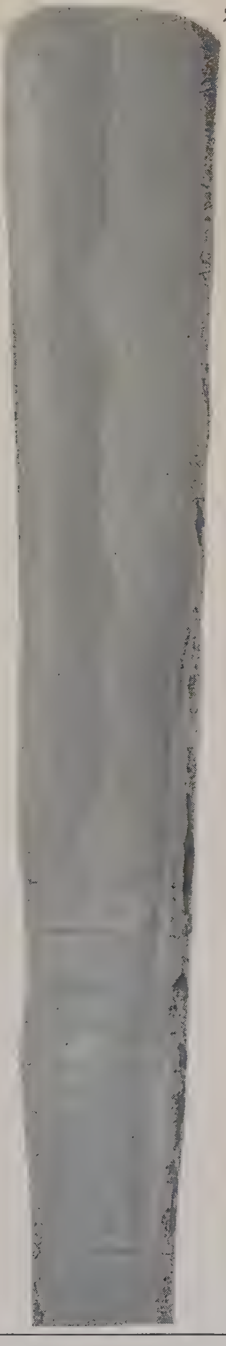

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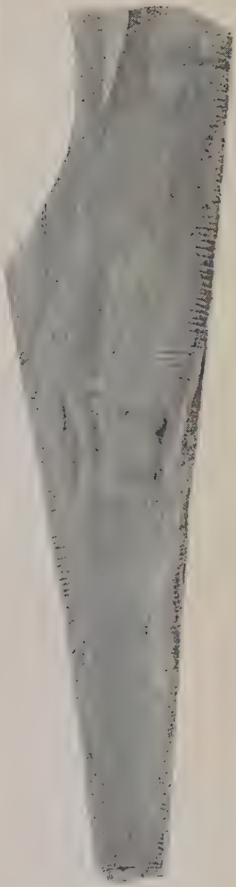

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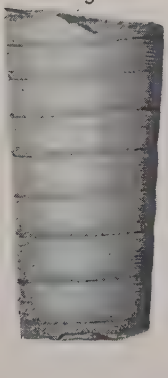

A. De C. et E. K. B. del.

Plate 13

Cycloceras persculptum nov.

Page 92

Figure 1 Holotype. Natural size. Upper Utica shale, Holland Patent, N. Y.

Spyroceras bilineatum (Hall)

Page 92

Figure 2 Compressed conch x2. Upper Utica shale, Holland Patent, N. Y.
Figure 3 Surface, x5.

Actinoceras crebriseptum (Hall)

(See plate 14, figures 1–4; plate 16, figure 7)

Page 100

Figure 4 Fragment of conch showing the sutures, septa and section of siphuncle. Natural size.

Figure 5 Fragment, x2, showing details of siphuncle with filling of central canal. Pulaski beds near Pulaski, N. Y.

Figure 6 Natural section of fragment of young conch, showing secondary deposits. Natural size.

The originals are in the New York State Museum.

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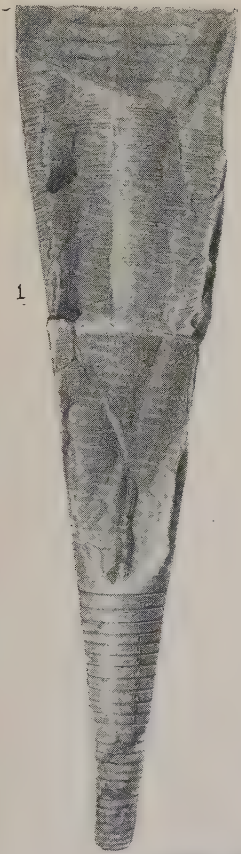

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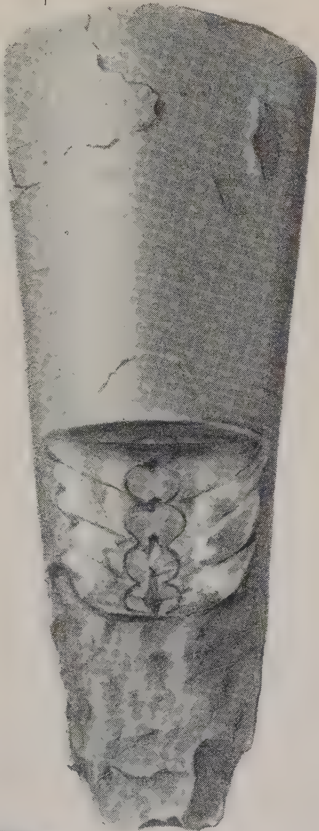

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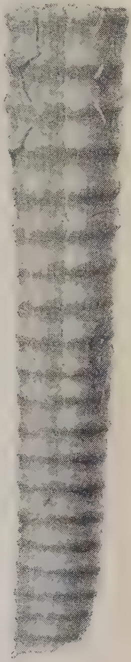

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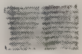

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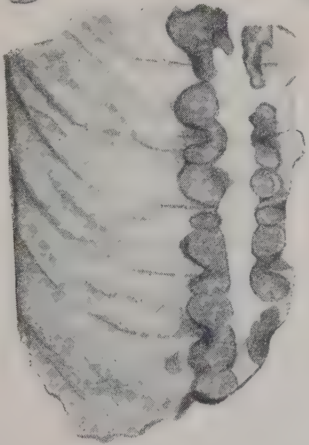

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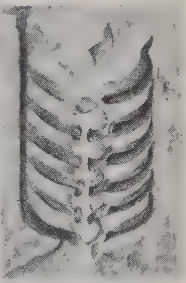

G. S. B. et E. K. B. del.

Plate 14

Actinoceras crebriseptum (Hall)

(See plate 13, figures 4–6; plate 16, figure 7)

Page 100

Figure 1 The common appearance of the fossil in the Lorraine drift, with the vacant spaces of the camerae and siphuncle filled by the matrix and the shell itself dissolved; shows endo-siphuncle as cylinder. Natural size. Pulaski drift near Trenton, N. Y.

Figure 2 Polished section of young conch to show subspherical segments of siphuncle. Natural size. Pulaski beds near Pulaski, N. Y.

Figure 3 Polished section of portion of conch showing heart-shaped section of segments and short funnels, x2. Pulaski beds near Pulaski, N. Y.

Figure 4 Young slightly compressed conch showing the rate of growth and the sutures. Natural size. Pulaski beds, Lorraine village, N. Y.

Paractinoceras lamellosum (Hall)

(See plate 15, figure 2)

Page 102

Figure 5 Young conch showing living chamber and sutures. Natural size. Pulaski drift, Oneida county, N. Y.

Figure 6 Larger specimen showing sutures and at lower end, siphuncle and septa. Natural size. Pulaski drift near Trenton, N. Y.

The originals are in the New York State Museum, except that of figure 5 which is in the National Museum.

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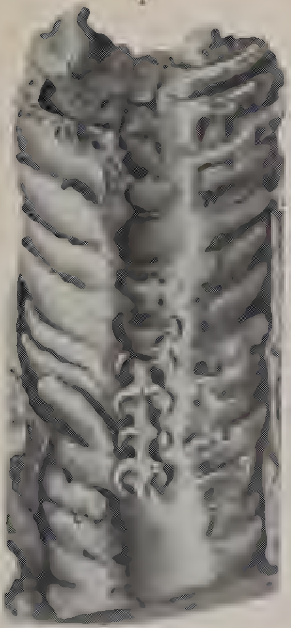

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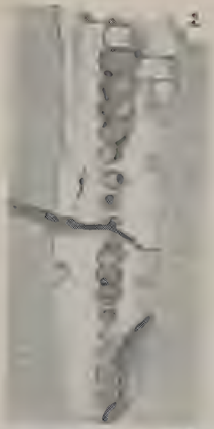

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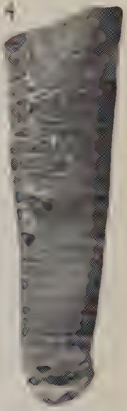

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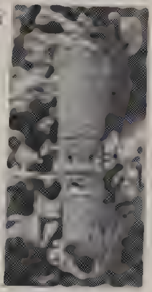

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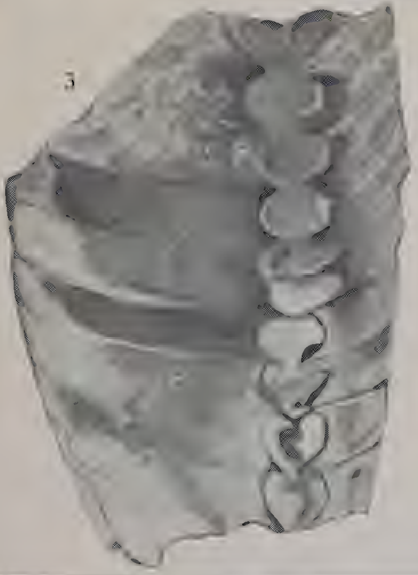

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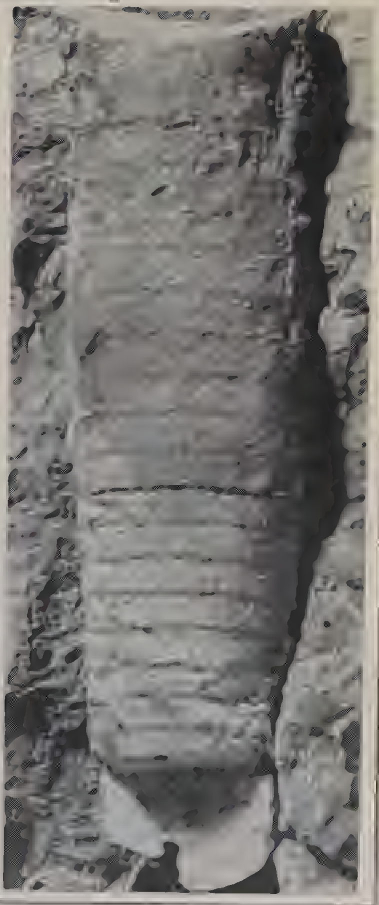


E. K. B. del. et J. A. G. photo.

Plate 15

7

Endoceras perannulatum nov.

Page 86

Figure 1 Holotype. Compressed specimen showing the annulations, rate of growth, surface lines and septa; all compressed into one plane. Natural size. Upper Utica shale, Holland Patent, N. Y.

Paractinoceras lamellosum (Hall)

(See plate 14, figures 5 and 6)

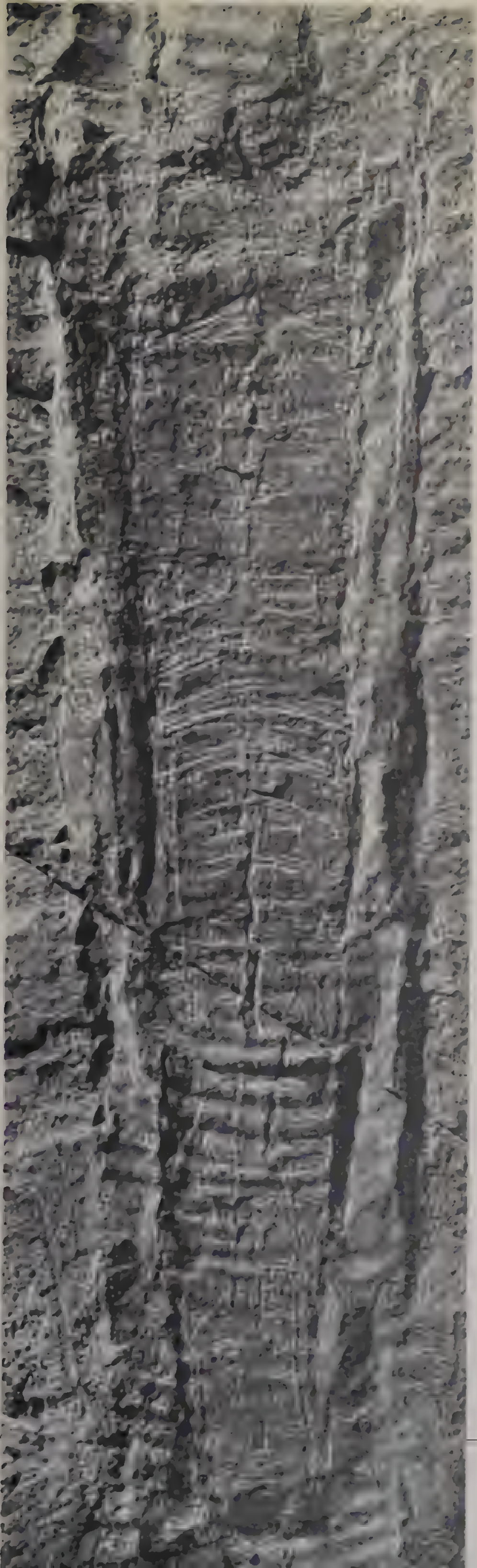
Page 102

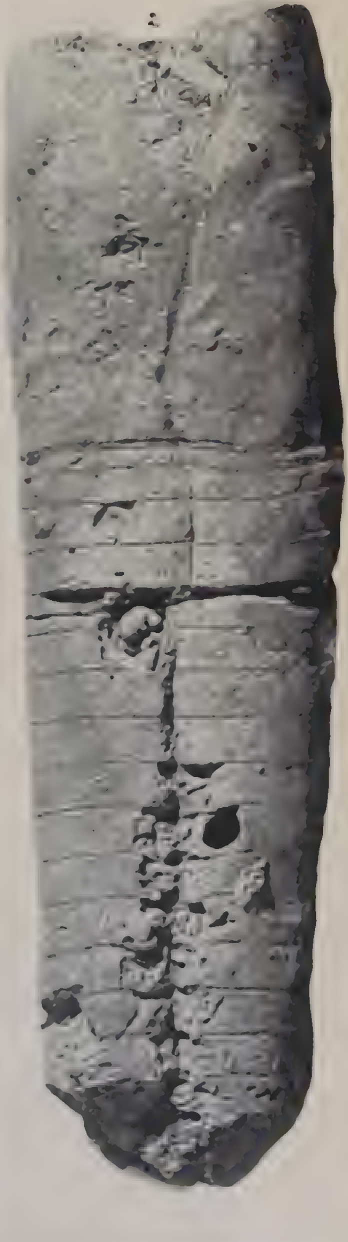
Figure 2 Portion of interior cast of mature conch retaining part of living chamber and the sutures. Natural size. Upper Pulaski beds, Salmon River falls, Oneida county, N. Y.

The originals are in the United States National Museum.

UTICA AND LORRAINE FOSSILS

Bulletin 272 Plate 15





J. A. Glenn photo.

Plate 16

Protokionoceras oneidaense (Walcott)

(See plate 10, figure 11)

Page 93

Figure 1 Well-preserved specimen, x2. Shows sculpture and slight curvature of conch. Upper Utica shale, Holland Patent, N. Y.

Oncoceras pupaeforme nov.

(See plate 19)

Page 104

Figure 2 Conch of immature female. Natural size. Upper Utica shale, Holland Patent, N. Y. Original of figure 6*a*, page 69, New York State Museum Bulletin 227–28.

Figure 3 Mature female with living chamber. Natural size. Upper Utica shale, Holland Patent, N. Y.

Paractinoceras (?) **pusillum** nov.

Page 103

Figure 4 Paratype. Natural size. Living chamber and a few camerae. Pulaski drift.

Figure 5 Paratype. View of septum with siphuncle opening. Natural size.

Figure 6 Holotype. Mature specimen showing living chamber and sutures. Natural size. Compare with plate 14, figure 5. Lorraine drift near Trenton, N. Y.

Actinoceras crebriseptum (Hall)

(See plate 13, figures 4–6; plate 14, figures 1–4)

Page 100

Figure 7 Very young conch. Natural size. Whetstone Gulf shale, Lorraine Gulf, N. Y.

Trocholites planorbiformis (Hall)

(See plate 18, figures 4 and 5)

Page 98

Figure 8 Large specimen showing nearly complete living chamber. Natural size. Pulaski drift, Oneida county, N. Y.

The originals are in the United States National Museum, except that of figure 8 which is in the New York State Museum.

UTICA AND LORRAINE FOSSILS

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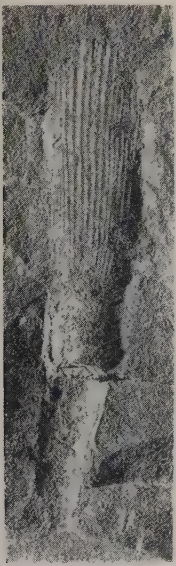

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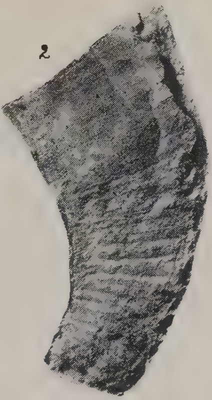

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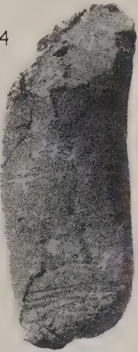

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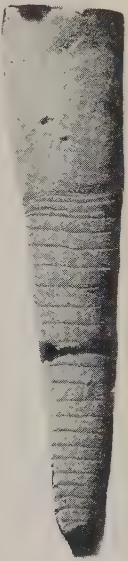

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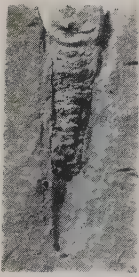

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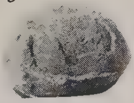

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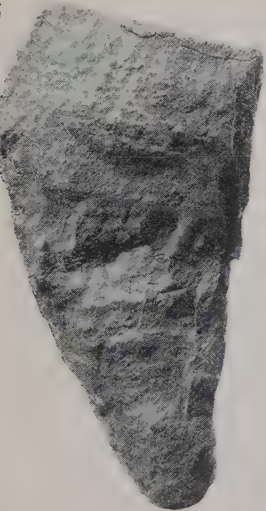

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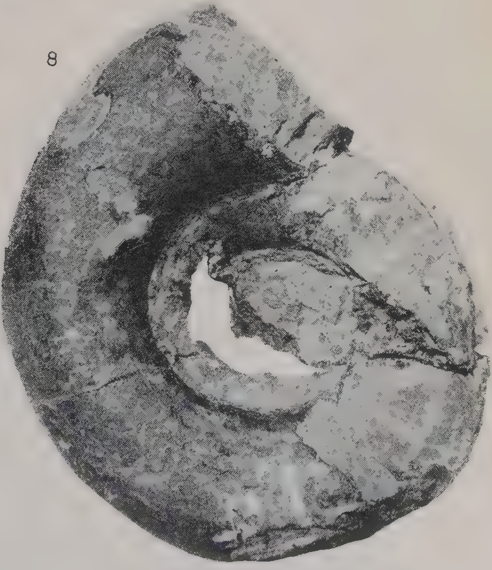

J. A. Glenn photo

Plate 17

Trocholites ammonius (Conrad) var. **major** nov.

(See plate 18, figures 1 and 2)

Page 97

Figure 1 Typical specimen showing living chamber, aperture and septa. Natural size.

Figure 2 Specimens retaining interior volutions. Natural size.

Figure 3 Fragment of large individual showing first volutions and early sutures. Natural size. Upper Utica shale, Holland Patent, N. Y.

Trocholites ammonius (Conrad)

(See plate 18, figures 1–3)

Page 94

Figure 4 Young conch fully retaining surface sculpture and sutures. Natural size. Upper Utica shale, Holland Patent, N. Y.

Trocholites ammonius (Conrad) var. **angustiumbilicatus** nov.

(See plate 18, figure 3)

Page 97

Figure 5 Typical specimen retaining living chamber and aperture. Natural size. Upper Utica shale, Holland Patent, N. Y.

All the originals are in the New York State Museum.

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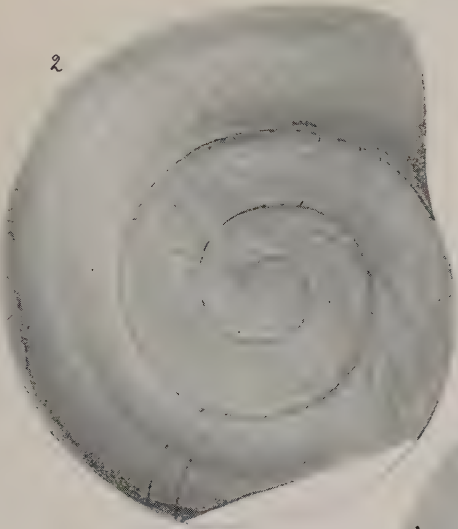

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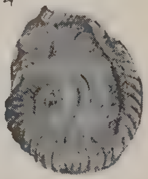

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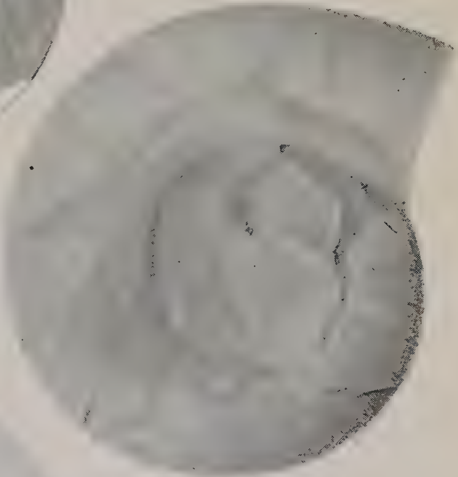

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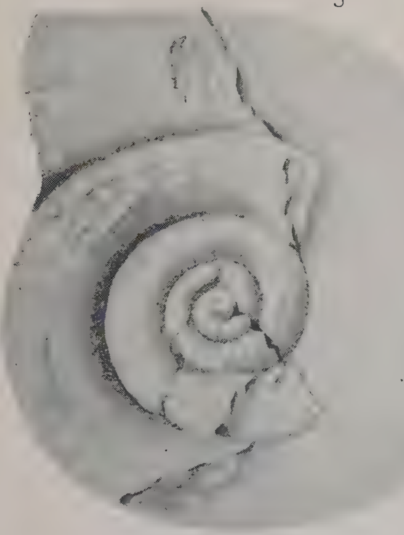

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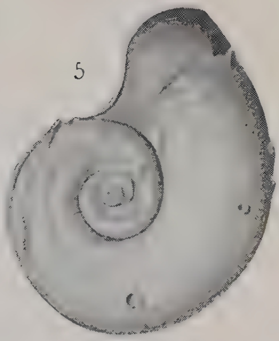


E. K. Bender del.

Plate 18

Trocholites ammonius (Conrad) var. **major** nov.

(See plate 17, figures 1–4)

Page 97

Figure 1 Large compressed specimen retaining all volutions and surface sculpture (x5 in figure 1*a* and 1*b*).

Figure 2 Living chamber and portion of preceding volution, retaining ribs. Natural size. Upper Utica shale. Holland Patent, N. Y.

Trocholites ammonius (Conrad) var. **angustiumbilicatus** nov.

(See plate 17, figure 5)

Page 97

Figure 3 Well-preserved specimen showing all volutions and aperture. Natural size. Upper Utica shale. Holland Patent, N. Y.

Trocholites planorbiformis (Conrad)

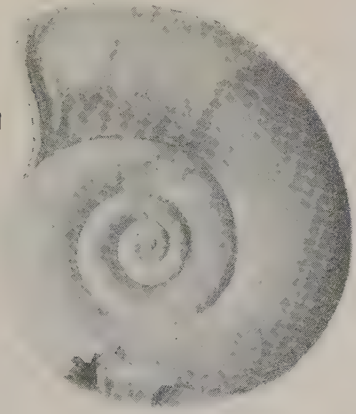
(See plate 16, figure 8)

Page 98

Figure 4 Finely preserved specimen showing external aspect of all volutions and aperture. Natural size. Drawn from squeeze. Pulaski beds, Pulaski, N. Y.

Figure 5 Dorsal view showing hyponomic sinus in growth-lines, Pulaski beds, Turin, N. Y.

The originals are in the New York State Museum, except that of figure 2, which is in the United States National Museum.



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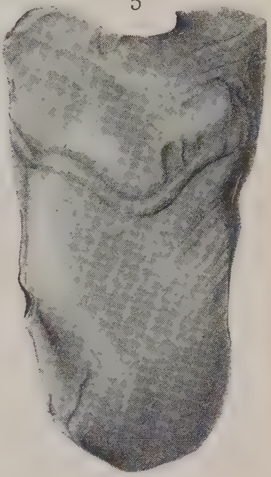

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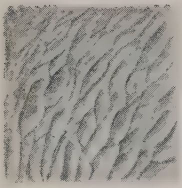

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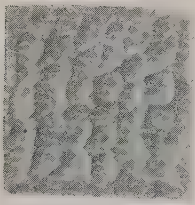

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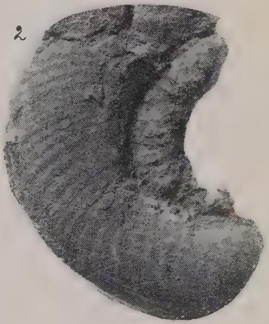

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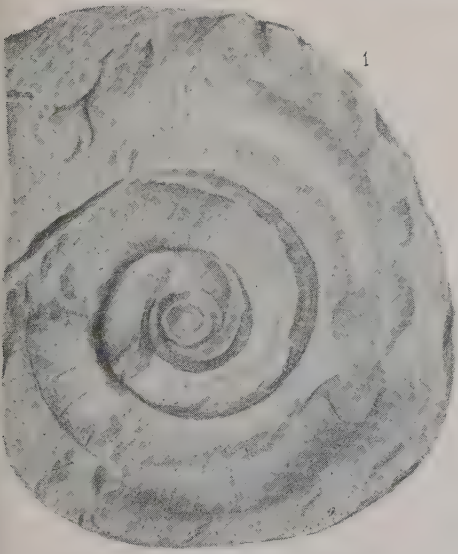

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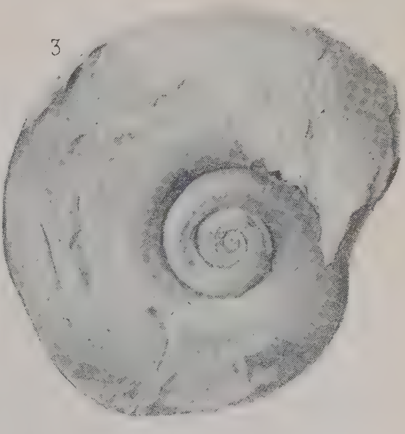

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E. K. B. del. et J. A. G. photo.

Plate 19

Oncoceras pupaeforme nov.

(See plate 16, figures 2 and 3)

Page 104

Figures 1 and 2 Paratypes, males, compressed in different directions.

Figure 3 Holotype. Mature female.

Figure 4 Paratype. Conch of male compressed in antero-posterior direction.

Figure 5 Paratype. Female showing distinct sutures and contracted living chamber.

Figure 6 Paratype, female. Camerate part sectioned and polished to show siphuncle.

Figure 7 Paratype. Anterior position of conch of female showing living chamber and curvature of sutures in lateral view.

Figure 8 Fragment of conch of female retaining surface sculpture and living chamber.

All specimens are from the upper Utica shale at Holland Patent, N. Y. and are drawn in natural size. The originals are in the New York State Museum.

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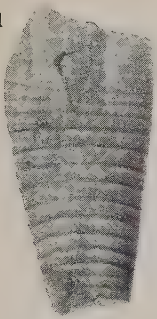

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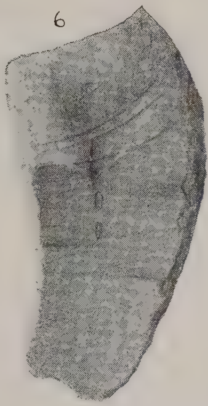

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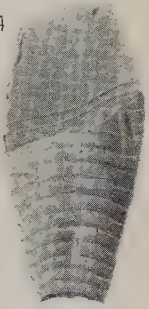

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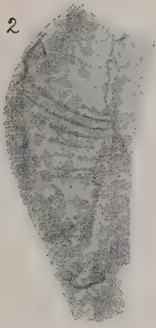

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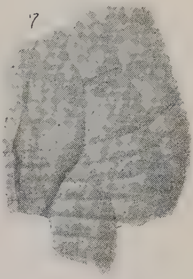

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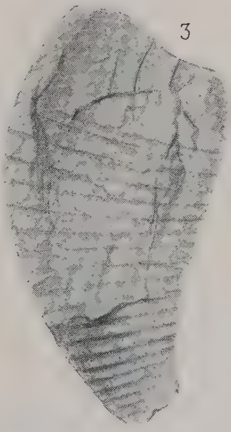

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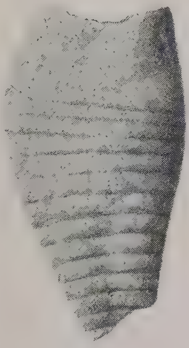

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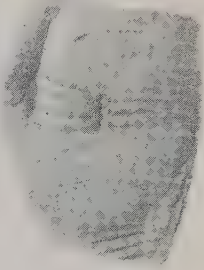

G. S. Barkentin del.

Plate 20

Endoceras lorrainense nov.

(See text figures)

Page 81

Figure 1 Paratype. Lateral view of camera with short section of siphuncle. Natural size.

Figure 2 Paratype, apical end of siphuncle. Natural size. Pulaski drift, near Trenton, N. Y.

Isotelus pulaskiensis Ulrich MS.

Page 128

Figure 3 Hypostoma. Natural size. Pulaski drift near Mansfield, Tioga county, Pa.

Homotelus stegops (Green)

(See plate 22, figures 1-9)

Page 126

Figure 4 Free cheek, x2. Whetstone Gulf shale, near Rome, N. Y.

Triarthrus huguiensis Foerste

Page 123

Figure 5 Well preserved cranidium, x2.

Figure 6 Well preserved cranidium, x4, less flattened than the preceding. Associated with other characteristic forms of the micro-fauna of the Whetstone Gulf shale, namely, Zygospira modesta (Say), Colpomya intermedia (Rued.) and Pterinea sp. nov. 1. Whetstone Gulf shale, station 12 of Mill creek section.

Calymene meeki Foerste

Page 133

Figure 7 Characteristic specimen. Interior cast (Calymene conradi Emmons). Natural size. Pulaski drift, Oneida county, N. Y.

Figure 8 Cranidium, x2. Whetstone Gulf shale, station 3 of Wood creek section.

The originals are in the New York State Museum, with the exception of those of figures 1, 2 and 4, which are in the United States National Museum.

UTICA AND LORRAINE FOSSILS

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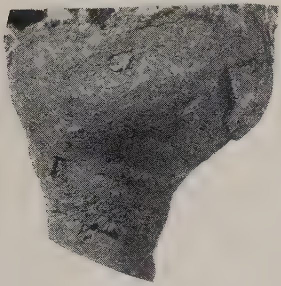

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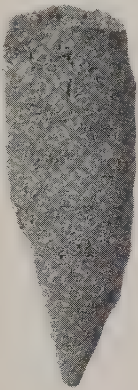

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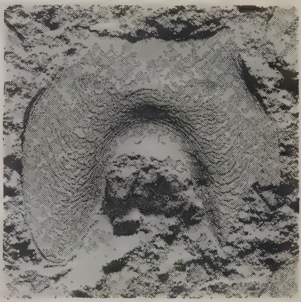

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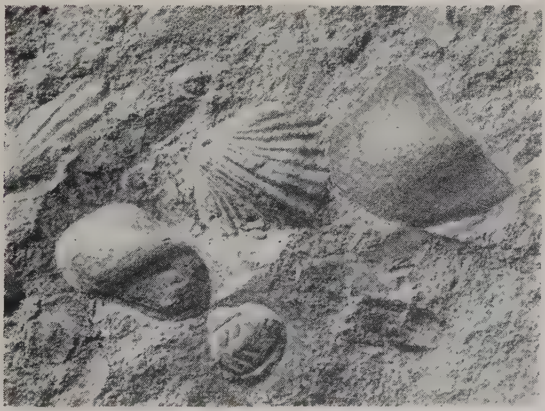

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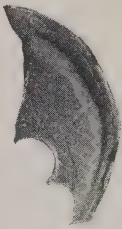

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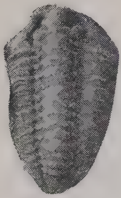

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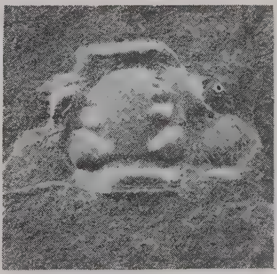

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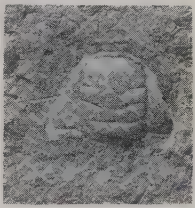

E. S. et J. A. G. photo.

Plate 21

Cryptolithus bellulus (Ulrich)[1]

Page 106

Figure 1 Top view of characteristic cranidium x2. Whetstone Gulf shale, station 1 of Wood creek section.

Figure 2 Side view of cranidium, x2.

Figure 3 Well-preserved cranidium, x5, to show details of sculpture. Whetstone Gulf shale, near Rome, N. Y.

Cryptolithus lorrainensis nov.

Page 107

Figure 4 Holotype. Natural size. One thoracic segment shoved under.

Figure 5 Paratype. Natural size. Specimen showing details of glabella and brim. Pulaski beds, Lorraine, N. Y.

Cryptolithus tesselatus (Green)

Page 107

Figure 6 Enrolled specimen showing relative position of pygidium and brim. Snake Hill beds, Snake Hill, Saratoga Lake, N. Y.

Triarthrus eatoni (Hall) emend. Ruedemann

Page 119

Figure 7 Typical cranidium. Natural size. Whetstone Gulf shale, Totman gulf near Watertown, N. Y.

Figure 8 A typical cranidium from the Utica shale. Natural size.

Figure 9 Complete specimen. Natural size. Lower Utica shale, Oxtungo creek near Fort Plain, N. Y.

Triarthrus becki Green, emend. Ruedemann

Page 115

Figure 10 Green's types. Original plaster cast sent out by Doctor Green. Natural size. From Snake Hill shale at Cohoes, N. Y.

Triarthrus becki Green

Page 115

Figure 11 Typical cranidia. Natural size. Canajoharie shale, Lake Champlain, N. Y. (U. S. loc. 34538).

Figure 12 Less compressed cranidia. Natural size. Canajoharie shale, Stony Point near Rouses Point, N. Y.

Triarthrus spinosus Billings

Page 121

Figure 13 Specimen retaining genal and nuchal spines and three of the posterior thoracic spines. Natural size.

Figure 14 Specimen retaining also part of pygidium. Natural size.

Figure 15 Specimen showing distinctly outline of cranidium. Natural size.

Figure 16 First of the thoracic spines with its segment. Natural size.

All four specimens are from the upper Utica shale at Holland Patent, N. Y.

The originals of the figures are in the New York State Museum, with the exception of those of figures 7, 9, 10 and 11, which are in the United States National Museum.

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[1] See also plate facing page 112 of New York State Museum Bulletin 258.

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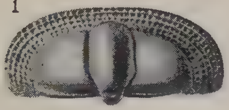

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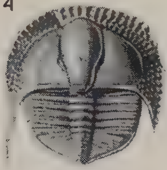

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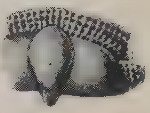

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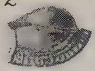

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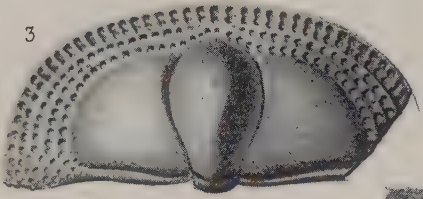

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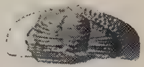

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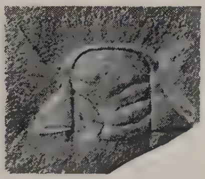

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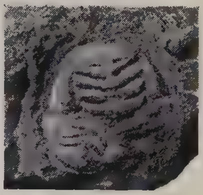

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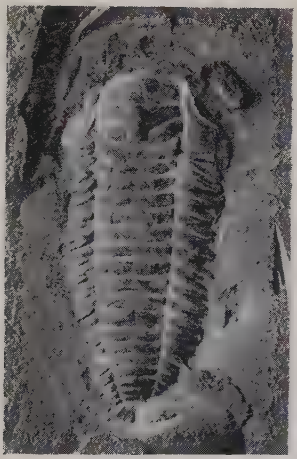

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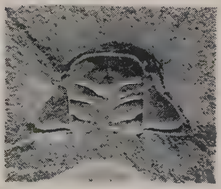

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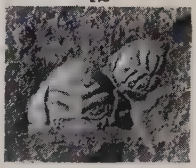

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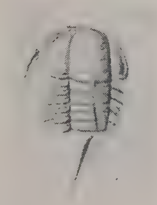

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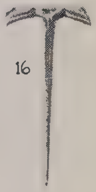

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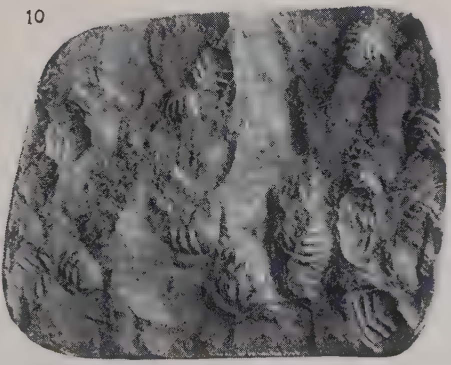

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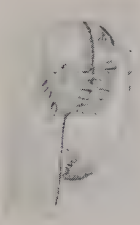

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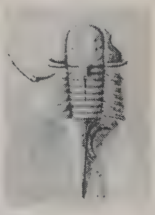

G. S. B. del. et E. S. photo.

Plate 22

Homotelus stegops (Green)

(See plate 20, figure 4)

Page 126

Figure 1 Cranidium of very young individual, x3. Whetstone Gulf shale, station 8 of Wood creek section.

Figure 2 A still younger species, x10. Utica–Frankfort transition beds. Holland Patent, N. Y.

Figure 3 Cranidium. Natural size. Whetstone Gulf shale, station 1 of Wood creek section.

Figure 4 Pygidium of very young stage. (Cf. Proetus spurlocki Meek) x5. Whetstone Gulf shale, station 10 of Wood creek section.

Figure 5 Still younger pygidium (Gerasaphes ulrichi Clarke) x15. Whetstone Gulf shale, near Rome, N. Y.

Figure 6 Pygidium of mature specimen. Natural size. Whetstone Gulf shale, station 1 of Wood creek section.

Figure 7 Fairly complete carapace. Natural size. Utica–Frankfort transition beds, Holland Patent, N. Y.

Figure 8 Pygidium of the spurlocki-stage, x5. Whetstone Gulf shale near Rome, N. Y.

Figure 9 Characteristic pygidium of mature specimen. Natural size. Whetstone Gulf shale, station 1 of Wood creek section.

Odontopleura ceralepta (Anthony)

Page 131

Figure 10 Well preserved carapace, x5. Whetstone Gulf shale near Rome, N. Y.

Odontopleura crosota (Locke)

Page 130

Figure 11 Cephalon, x5. Whetstone Gulf shale near Rome, N. Y.

Proetus beecheri nov.

Page 128

Figure 12 Paratype. Average size specimen, x3.

Figure 13 Holotype. Younger, better preserved individual, x4.

Figure 14 Cephalon of mature specimen. Paratype, x4. Frankfort shale, Seven Mile creek near Rome, N. Y.

The originals are in the New York State Museum, with the exception of those of figures 12–14, which are in the Yale (Peabody) Museum.

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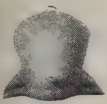

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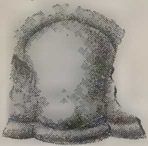

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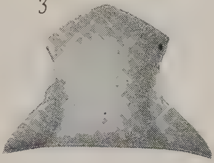

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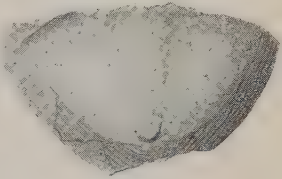

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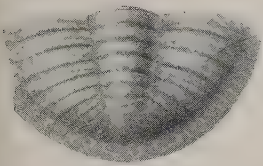

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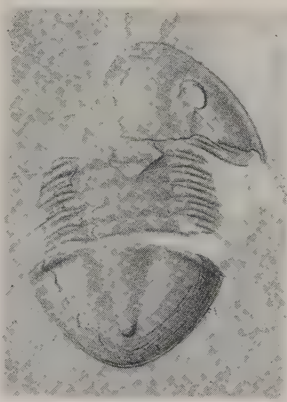

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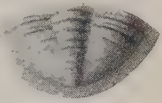

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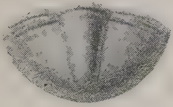

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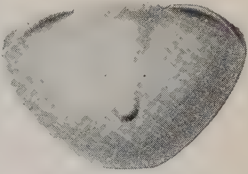

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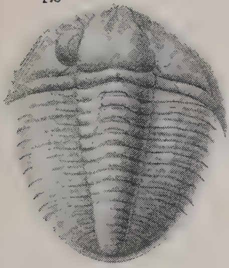

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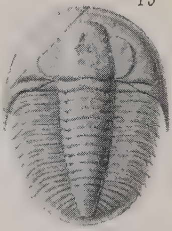

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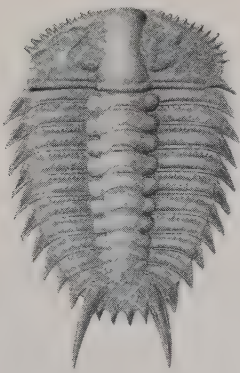

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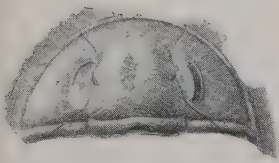

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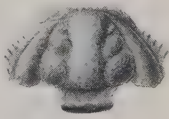

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Plate 23

Aparchites minutissimus (Hall)

Page 138

Figure 1 Interior cast of left valve, x15. Whetstone Gulf shale, station 6 of Lorraine gulf section.

Figure 2 Left valve, x15. Whetstone Gulf shale, station 10 of Wood creek section.

Primitia rudis Ulrich

Page 139

Figure 3 Typical left valve, x15. Whetstone Gulf shale, station 9 of Whetstone gulf section.

Figure 4 Another specimen of slightly different outline, x14. Whetstone Gulf shale, station 7 of Whetstone gulf section.

Figure 5 Small right valve, x15. Whetstone Gulf shale, station 4 of Lorraine gulf section.

Primitiella unicornis (Ulrich)

Page 137

Figure 6 Characteristic specimen (right valve) x15. Whetstone Gulf shale, station 6 of Whetstone gulf section.

Primitia centralis Ulrich

Page 138

Figure 7 Right valve, x15. Whetstone Gulf shale, station 4 of Lorraine gulf section.

Bollia uticana nov.

Page 140

Figure 8 Holotype, x15. Figured from squeeze. Upper Utica shale, Holland Patent, N. Y.

Bollia pulchra nov.

Page 141

Figure 9 Holotype, x15. Whetstone Gulf shale, Chimney Point near Martinsburgh, N. Y.

Figure 10 Paratype. Right valve, x15. Frankfort shale near Rome, N. Y.

Figure 11 Specimen, right valve, x15. Whetstone Gulf shale near Rome, N. Y.

Figure 12 Right valve, x15. Whetstone Gulf shale, station 1 of Wood creek section.

Jonesella pedigera Ulrich

Page 140

Figure 13 Well-preserved right valve, x15.

Figures 14 and 15 Two right valves showing somewhat different characters (figure 14 x 15; figure 15 x 16). Whetstone Gulf shale, station 6 of Lorraine gulf section.

Elpe radiata Ulrich

Page 144

Figure 16 Specimen showing characteristic sculpture, x15. Deer River shale. Allendale bridge at mouth of Lorraine gulf.

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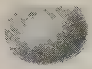

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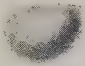

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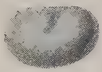

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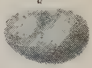

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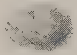

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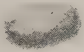

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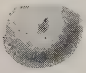

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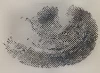

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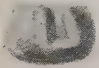

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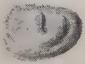

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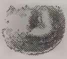

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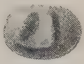

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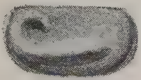

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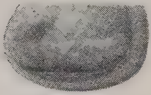

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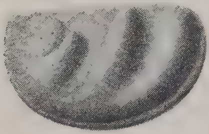

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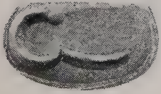

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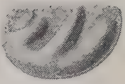

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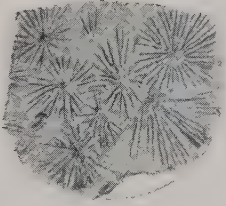

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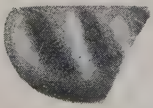

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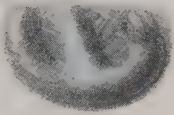

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Ceratopsis oculifera (Hall)

Page 143

Figure 17 Well-preserved left valve, x15.

Figure 18 Right valve, x16.

Figure 19 Right valve with stronger lobes, x15.

Figure 20 Left valve showing character of margin, x25. Pulaski beds near Pulaski, N. Y.

The originals are in the New York State Museum.

Plate 24

Eobalanus informans Ruedemann

Page 146

Figure 1 Paratype. Natural size.

Figure 2 Holotype and paratype. Natural size.

Figure 3 Holotype, x5.

Figure 4 Paratype. Shown in figure 2, x5. Upper Utica shale, Holland Patent, N. Y.

The original of figure 1 is in the United States National Museum; those of the others are in the New York State Museum.

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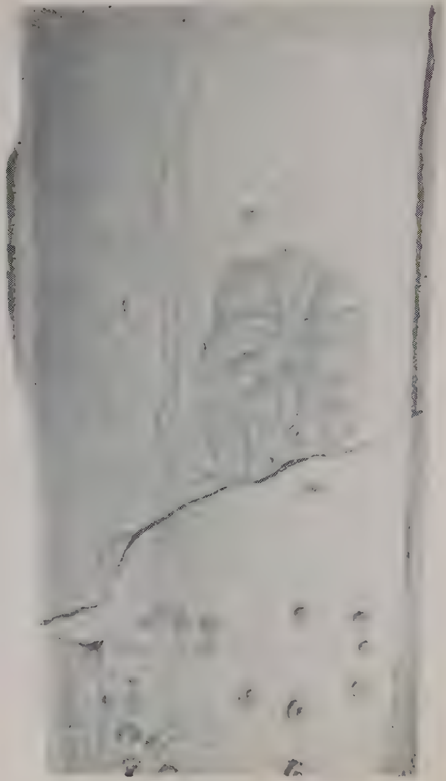

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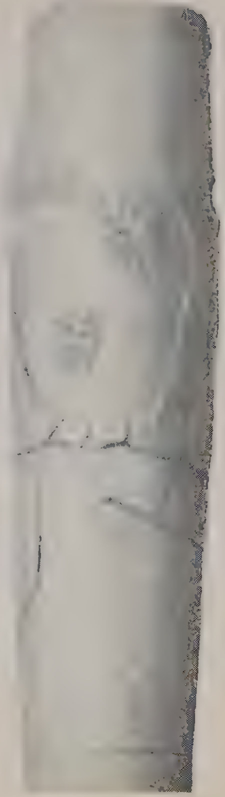

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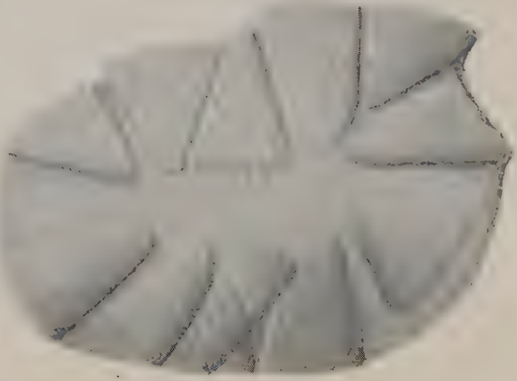

G. S. Barkentin del.

Plate 25

Lepidocoleus jamesi (Hall and Whitfield)

Page 145

Figures 1 and 2 Plates from the basal Pulaski beds (station 22 of the Lorraine gulf section). Figure 1 x15; figure 2 x10.

Figure 3 Plate, x18. Whetstone Gulf shale, station 1 of Wood creek section.

Ceratiocaris timida nov.

Page 147

Figure 4 Single group of specimens known, preserved in the paragaster of a sponge. Natural size. The largest individual is the holotype. Upper Utica shale, Holland Patent, N. Y.

The originals of the first three figures are in the New York State Museum, that of figure 4 is in the United States National Museum.

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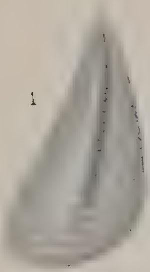

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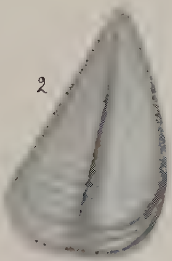

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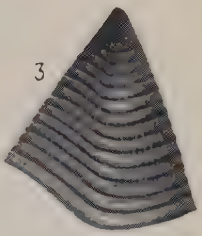

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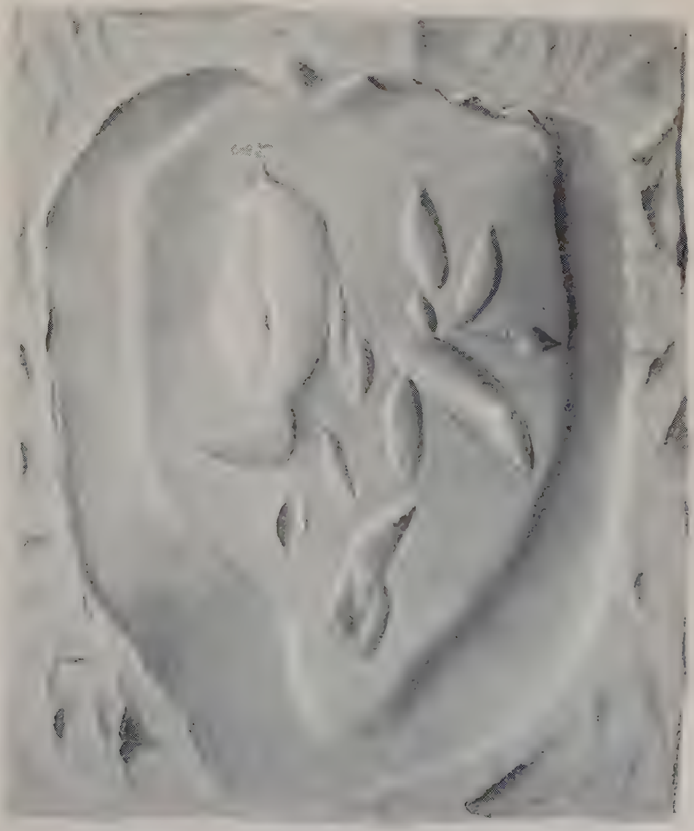

G. S. B. et E. K. B. del.

Plate 26

Dolichopterus insolitus nov.

Page 151

Figure 1 Holotype. Natural size. Upper Utica shale, Holland Patent, N. Y.

Eusarcus breviceps nov.

Page 152

Figure 2 Holotype. Natural size. Upper Utica shale, Holland Patent, N. Y.

Hughmilleria uticana nov.

Page 153

Figure 3 Holotype. Natural size. Upper Utica shale, Holland Patent, N. Y.

Stylonurus sp.

Page 150

Figure 4 Leg segment. Natural size. Whetstone Gulf shale near Rome, N. Y.

Echinognathus clevelandi (Walcott)

Page 149

Figure 5 Patch of marginal integument showing surface sculpture. Upper Utica shale, Holland Patent, N. Y.

Ceratiocaris sp.

Page 148

Figure 6 Group of telson-spines of an undescribed species. Natural size. Whetstone Gulf shale near Rome, N. Y.

The originals are in the New York State Museum, with the exception of that of figure 3, which is in the United States National Museum.

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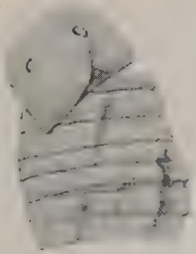

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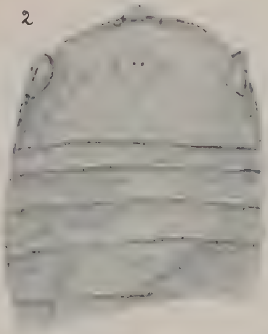

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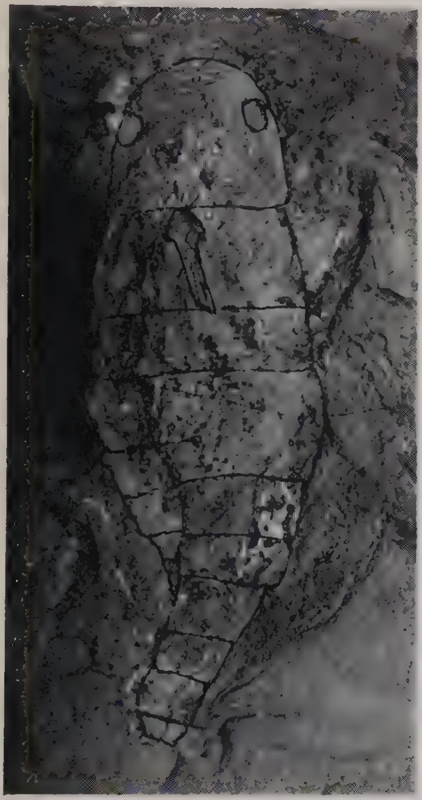

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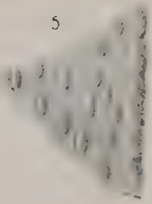

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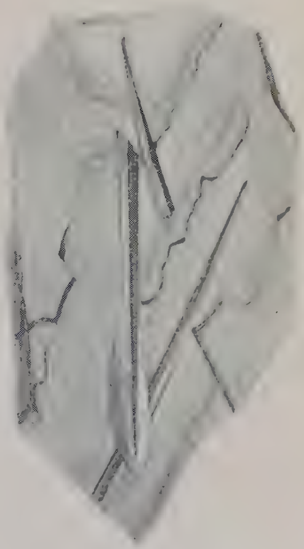


G. S. B. et E. K. B. del.; R. S. B. photo.

Plate 27

Eurypterus rusti nov.

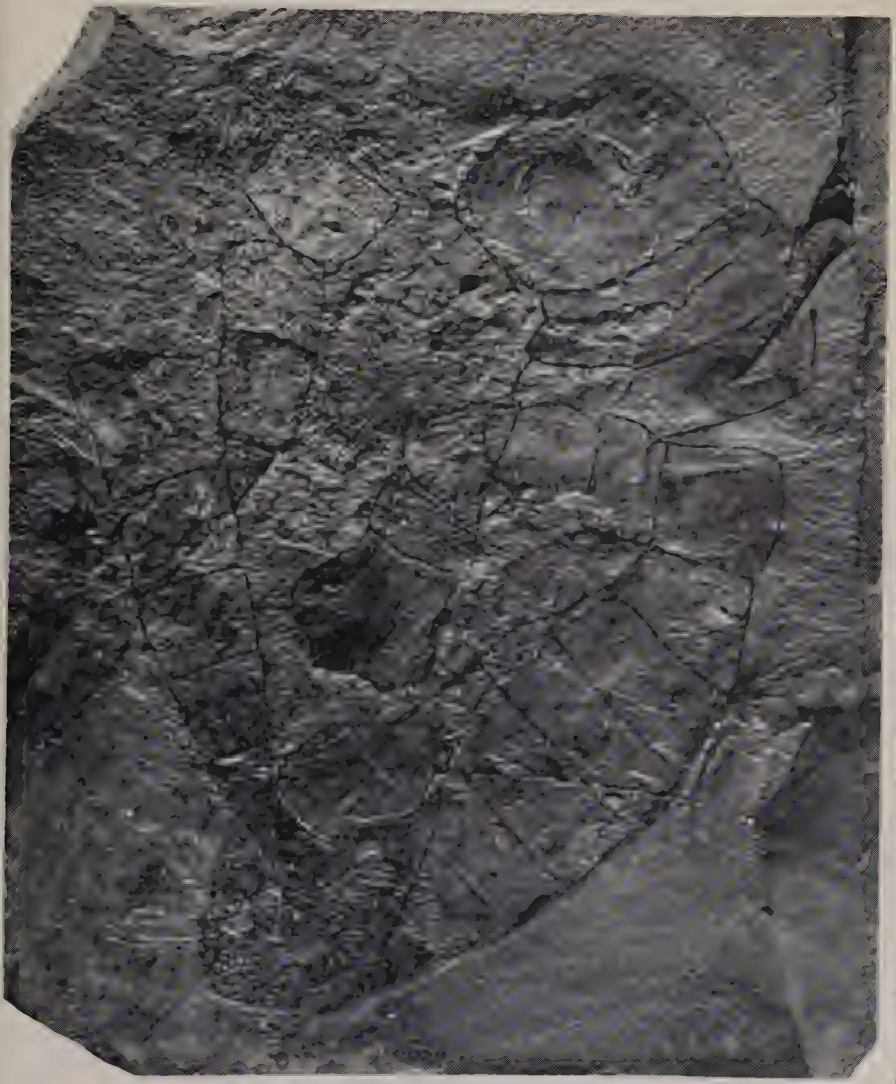
Page 150

Holotype, Natural size. The specimen in upper part of group.

Pterygotus walcotti nov.

Page 154

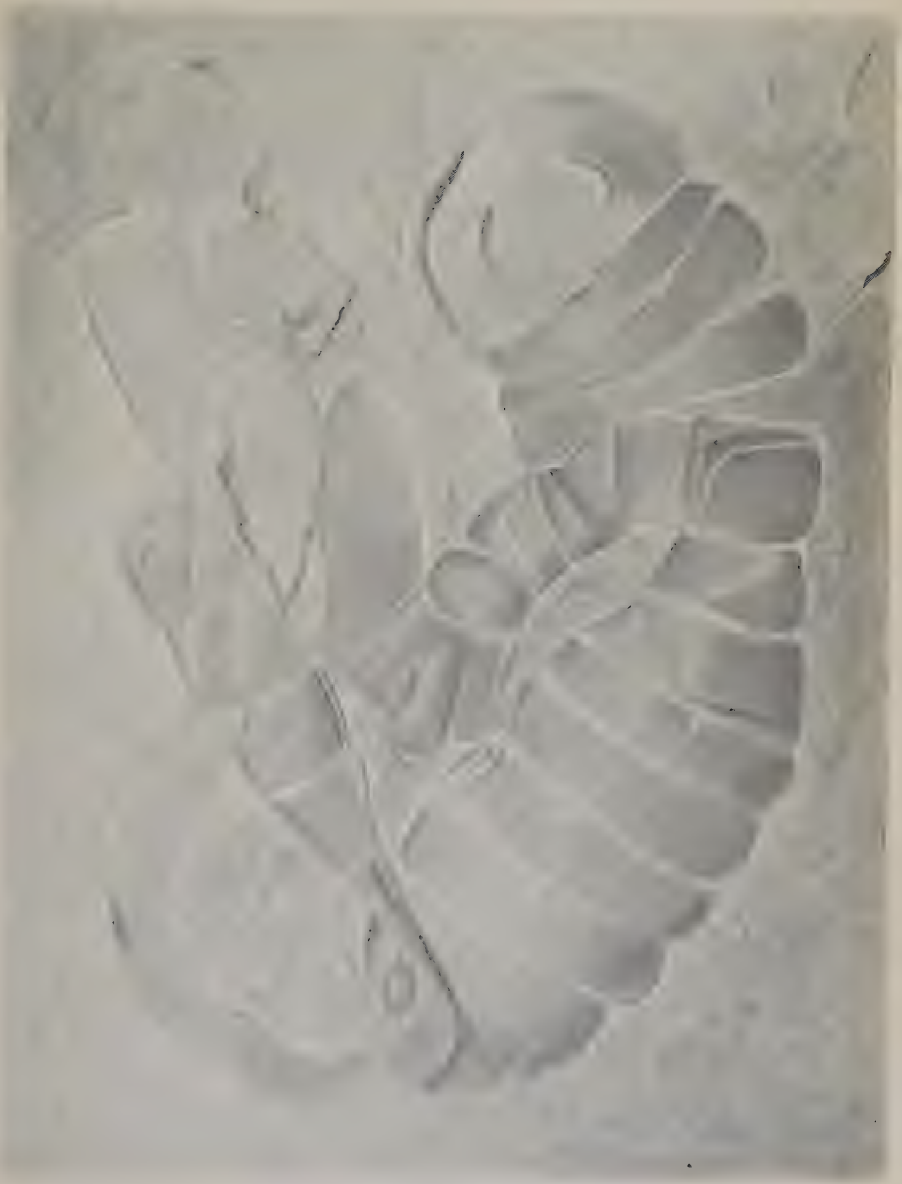
Lower part. Holotype. Upper Utica shale, Holland Patent, N. Y. The original is in the United States National Museum.



J. A. Glenn photo.

Plate 28

A drawing of the group shown on preceding plate from gelatine tracings by the author, to show more clearly the different remains.



E. K. Bender del.

INDEX

Actinoceras crebriseptum, 100
Ami, H. M., cited, 96, 125
Anthony, John G., cited, 131
Aparchites minutissimus, 138
Archinacella pulaskiensis, 59
  subcarinata, 58

Barrande, cited, 101
Bassler, R. S., cited, 14, 15, 16, 20, 29, 32, 37, 44, 48, 51, 52, 68, 73, 74, 75, 77, 80, 96, 106, 107, 118, 124, 125, 127, 139, 140
Beecher, C. E., cited, 108, 113, 120, 129
Bibliography, 165–68
Billings, E., cited, 70, 101, 121, 147
Bollia sp. aff. pulchra, 142
  pulchra, 141
  uticana, 140
Byssonychia carinata, 30
  hyacinthensis, 31
  praecursa, 30
  radiata, 27
  vera, 29
    var. pluricosta, 30
Bythocypris cylindrica, 144

Calymene senaria mut. granulosa, 133
  mut. meeki, 133
  var. magnotuberculata, 136
Ceratiocaris sp., 148
  (Limnocaris) timida, 147
Ceratopsis chambersi, 143
  oculifera, 143
Chapman, E. J., cited, 125
Clark, Thomas H., cited, 147
Clarke, John M., cited, 43, 127, 131, 133, 135, 137, 149, 154, 155
Clathrospira conica, 73
  subconica, 73
Cleland, H. F., 24; cited, 78
Clidophorus planulatus, 16
  scitulus, 19
Colpomya faba mut. intermedia, 41
  mut. pusilla, 40
Conrad, T. A., cited, 16, 20, 23, 32, 33, 34, 35, 42, 46, 54, 60, 94, 98
Conularia granulata, 80
  hudsoni, 78
  trentonensis mut. latior, 79
Cryptolithus bellulus, 106
  lorrainensis, 107
Ctenodonta borealis, 13
  filistriata, 14
  lorrainensis, 12
  nuculiformis, 10
  pectunculoides, 11
  perminuta, 15
  pulchella, 14
Cumings, E. R., cited, 76
Cuneamya elliptica, 8
  scapha, 9
    cf. mut. brevior, 9
  sp. aff. neglecta, 7
  subquadrangularis, 6
Cycloceras persculptum, 92
Cyclora, 76
  minuta, 77
  parvula, 77
  cf. pulcella, 77
Cymatonota parallela, 46
  pholadis, 46
Cyrtolites ornatus, 60

Dall, cited, 62
Dana, J. D., cited, 116
Dilobella lorrainensis, 142
Dolichopterus insolitus, 151

Eaton, Amos, cited, 107
Eccyliomphalus trentonensis mut. fimbriatus, 74
Echinognathus clevelandi, 149
Elpe radiata, 144
Emmons, Ebenezer, cited, 16, 19, 23, 24, 27, 30, 33, 35, 40, 42, 56, 62, 63, 94, 120, 134
Endoceras sp., 81
  coralliferum, 84
  lorrainense, 81
  perannulatum, 86

Endoceras (*continued*)
  proteiforme, 80
  romanum, 84
Eobalanus informans, 146
Eotomaria sp. cf. canalifera, 72
  pagoda, 72
Eurypterus? rusti, 150
Eusarcus breviceps, 152
Explanation of plates, 169–227

Faber, C. S., cited, 64, 145
Foerste, A. F., cited, 7, 8, 9, 11, 12, 13, 14, 17, 19, 20, 21, 22, 24, 27, 29, 30, 31, 32, 33, 38, 39, 40, 41, 43, 44, 45, 46, 47, 49, 50, 51, 56, 58, 59, 60, 64, 65, 66, 68, 73, 76, 84, 99, 101, 106, 107, 108, 111, 113, 119, 123, 127, 128, 129, 130, 134, 135, 136, 139, 140, 143, 144, 145, 146
Foord, A. H., cited, 87, 98, 101
Fritz, Madelaine, cited, 60, 81, 101

Geisonoceras spec. indet., 92
  amplicameratum, 90
  strigatum, 91
  tenuistriatum, 88
    var. frankfortense, 89
  tenuitextum, 90
Goldfuss, A., cited, 30
Grabau, A. W., cited, 94
Green, Jacob, cited, 107, 109, 115, 116, 126

Hadding, Assar, cited, 119
Hall, James, cited, 7, 10, 11, 14, 16, 20, 23, 24, 27, 30, 33, 34, 35, 37, 39, 40, 42, 44, 46, 54, 56, 57, 60, 62, 65, 66, 67, 69, 73, 76, 77, 78, 84, 88, 90, 91, 94, 97, 98, 100, 102, 107, 108, 116, 117, 119, 124, 125, 134, 136, 137, 138, 143, 144
Harlan, R., cited, 115
Holm, cited, 80
Holopea varicosa, 76
Homotelus stegops, 126
Hormotoma gracilis var. sublaxa, 67
  salteri, 68
Hovey, E. O., cited, 30, 38, 40, 47, 66, 124
Hughmilleria uticana, 153
Hyatt, Alpheus, cited, 95, 97, 98, 99
Hyolithes pumilus, 77

Ischyrodonta unionoides, 19
Isotelus pulaskiensis, 128

Jaekel, O., cited, 113
James, J. F., cited, 87
Jones, T. R., cited, 137, 143
Jonesella pedigera, 140

Koken, cited, 62

Lepidocoleus jamesi, 145
Liospira micula, 69
  vitruvia, 70
List of species and varieties of Utica and Lorraine formations of New York, 156–64
Lophospira abbreviata, 65
  cf. bicincta, 65
  bowdeni, 64
  lirata, 67
Lyrodesma cincinnatiense, 57
  conradi, 55
  planum, 54
  poststriatum, 56

Matthew, G. F., cited, 147
Meek, F. B., cited, 20, 130, 131, 134, 145
Miller, S. A., cited, 64, 76, 105, 131, 143
Modiodesma modiolare, 32
  var. angustifrons, 34
  var. brevius, 34
Modiolodon truncatus, 39
Modiolopsis anodontoides, 35
  curta, 37
  ovata, 34

Odontopleura ceralepta, 131
  crosota, 130
Ogygites canadensis, 124
  latimarginata, 124
Oncoceras pupaeforme, 104
O'Neill, J. J., cited, 12
Orthoceras cf. transversum, 87
Orthodesma pulaskiense, 38

Paractinoceras lamellosum, 102
  pusillum, 103
Parks, W. A., cited, 60, 81, 101
Pholadomorpha nasuta, 45
  pholadiformis, 44
Plates, explanation of, 169–227
Plethospira quadricarinata, 71
Primitia centralis, 138
  rudis, 139
Primitiella unicornis, 137
Proetus beecheri, 128
Prolobella corrugata, 38
Protokionoceras oneidaense, 93
Psiloconcha sinuata, 49
  subovalis, 49
Pterinea (Caritodens) demissa, 23
  insueta, 23
  obtusiformis, 26
Pterygometopus cf. callicephalus, 137
Pterygotus walcotti, 154

Raymond, P. E., cited, 107, 108, 123, 127, 132
Reed, F. R. Cowper, cited, 107, 108, 110, 114, 119, 132
Rhytimya, 54
  cancellata, 52
  compressa, 50
  obesa, 53
  plana, 51
  producta, 51
  radiata, 50
Richter, R. & E., cited, 132
Ruedemann, Rudolf, cited, 14, 23, 43, 79, 89, 91, 106, 108, 131, 137, 138, 143, 149, 154, 155
Ruedemannia, 66

Safford, cited, 64
Scofield, cited, 60, 62, 65, 68, 69, 70, 73, 76
Seelya sp., 70
Shimer, cited, 94
Sinuites cancellatus, 62
  granistriatus, 63
  planodorsatus, 61
Slater, cited, 80
Species and varieties of Utica and Lorraine formations of New York, list of, 156–64
Spyroceras bilineatum, 92
Stewart, B. H., cited, 14, 19, 21, 29, 33, 41, 44, 46, 51, 58,
Strophostylus gregarius, 75
Stylonurus sp., 150

Tetranota rugosa, 63
Triarthus becki, 115
  eatoni, 119
  huguiensis, 123
  spinosus, 121
Trocholites ammonius, 94
  planorbiformis, 98
Trochonema (Eunema) nitidum, 74
Twenhofel, W. H., cited, 118

Ulrich, E. O., cited, 7, 9, 12, 13, 14, 15, 20, 26, 27, 29, 30, 33, 34, 35, 39, 40, 41, 43, 44, 45, 46, 48, 50, 52, 54, 55, 57, 60, 61, 62, 63, 64, 65, 68, 69, 70, 72, 73, 74, 76, 108, 125, 126, 128, 137, 138, 139, 140, 143, 144

Vanuxem, Lardner, cited, 27, 30
Vogdes, A. W., cited, 131, 132

Walcott, C. D., cited, 52, 53, 93, 120, 133, 149
Weller, Stuart, cited, 7, 69
Whiteaves, J. F., cited, 99
Whiteavesia nasutà, 42
Whitella goniumbonata, 22
Whitfield, R. P., cited, 11, 24, 30, 38, 40, 44, 47, 66, 124